CLIMATIC VARIABILITY IN SOUTHWESTERN ROMANIA IN THE CONTEXT OF CLIMATE CHANGES DURING THE WINTER OF 2018-2019

MARINICĂ Andreea Floriana, MARINICĂ Ion, CHIMIŞLIU Cornelia

Abstract. Although the warm and dry autumn of 2018 ended sooner from a meteorological point of view, with the intense cooling of the night of November 18/19, 2018, and winter phenomena began suddenly, on the whole, the winter 2018-2019 was warm (W) with a general average of 0.55°C and a 1.5°C deviation from the normal values. December was thermally normal and slightly rainy, but it interrupted the autumn excessive drought. January was warm and, in pluviometric terms, exceptionally rainy (ER), which restored the ground water reserve. February was warm (W) and exceptionally dry, but the ground water reserve remained almost optimal due to the persistence of the snow layer, especially in the hilly area. The climatic variability of this winter was particularly high and climatic warming continued, although the solar activity was minimum and the El Niño process was absent. The paper is part of an extensive series of studies on climate variability in southwest Romania and climate change at regional level and it is useful to all those interested in climate issues and its evolution in this part of Romania.

Keywords: temperature monthly averages, Hellmann criterion, warm winter phenomena, cold waves, vegetative processes.

Rezumat. Variabilitatea climatică în iarna 2018-2019 în sud-vestul României în contextul schimbărilor climatice. Deşi toamna călduroasă şi secetoasă 2018 s-a încheiat din punct de vedere meteorologic mai devreme, odată cu răcirea intensă a vremii din noaptea de 18/19 noiembrie 2018 şi fenomenele de iarnă au început brusc, iarna 2018-2019 a fost în ansamblul său caldă (C) cu media anotimpuală generală de 0,55°C şi abaterea faţă de normală de 1,5°C. Luna decembrie a fost termic normală şi puţin ploioasă şi a întrerupt seceta excesivă a toamnei. Luna ianuarie a fost călduroasă, iar din punct de vedere pluviometric a fost excesiv de ploioasă (EP), ceea ce a refăcut rezerva de apă din sol. Luna februarie a fost caldă (C) în ansamblul său şi excesiv de secetoasă, dar rezerva de apă din sol s-a menţinut aproape de optim datorită persitenţei stratului de zăpadă mai ales în arealul dealurilor. Variabilitatea climatică a acestei ierni a fost deosebit de mare, iar încălzirea climatică a continuat deşi activitatea solară a fost la minim şi procesul climatic El Ninõ a fost absent. Lucrarea face parte dintr-o serie extinsă de studii privind variabilitatea climatică în sud-vestul României şi schimbările climatice la nivel regional şi este utilă tuturor celor intersaţi de problemele climatului şi evoluţia acestuia în această parte a României.

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

INTRODUCTION

In January 2019, according to The Weather Department, weather forecasts indicated that, by the end of 2019, "19 of the warmest 20 years ever recorded on Earth were after 2000," (Professor Adam Scaife, Head of the Long Range Forecasting Department of The Weather Department). Dr. Doug Smith, a researcher at The Weather Department, said that "the forecast for 2019 places this year among the warmest five years so far, all of them being registered after 2015". "All these years were about 1°C warmer than the pre-industrial period." WMO indicated that 2018 was among the warmest four years ever recorded, ranking after 2016, 2015, and 2017. It was projected that, in 2019, global average temperatures would be about 1.10°C higher than the pre-industrial period, thus close to those registered in the ***record year 2016*** when temperatures were 1.15°C above the average of the period 1850-1900 (Agerpres). The estimates issued by The Weather Department at the end of 2017 for 2018 were close to what was actually recorded in 2018. (https://www.digi24.ro/meteo/meteorologi-2019-ar-putea-fi-unul-dintre-cei-mai-calzi-ani-din-istorie-1052159). Global warming continued in 2018 even though solar activity was minimum and the El Niño climate process was absent. Thus, in terms of *average global temperature*, 2018 was the fourth hottest year in the history of rigorous climatic observations on Earth, and climate change trends show that temperatures will continue to increase, based on the data supplied by NOAA and NASA. The data of the two agencies show that the global average of 2018 atmospheric temperatures was 0.79°C higher than the average of the 20th century temperature of 13.9°C (Science News). The warming trend became evident in the mid-1970s. For much of the Southern Hemisphere, 2018 marked a record in terms of maximum and average temperatures for the second consecutive year. Certain *regions in the Northern Hemisphere* also recorded the highest average temperatures, including some parts of Europe, the Middle East and the West of the Pacific. In the Arctic region, temperatures continued to increase faster than global average temperatures. In *Romania*, the average annual air temperature in 2018 was 11.57°C, this being the third highest value since 1901 to date, according to recordings from long-term meteorological stations (N.A.M.). The average air temperature in 2018 exceeded by 1.35°C the climatological average for the period 1981-2010 (according to the Deputy Prime Minister and Minister of the Environment, Graţiela Gavrilescu). In *Oltenia*, the average annual temperature in 2018 calculated for the whole region was 11.76°C, and the deviation from the general average of the last century was 1.94°C, which shows that, at the regional level, Oltenia is one of the warmest regions of Romania. In this context, climatic variability was particularly high in Oltenia during the year 2018. After the warm spring, when ***April had the highest monthly climatic averages in the history of climate observations,*** not only in Romania, but also within most of Europe, summer started with exceptionally rainy weather in the first two months. Autumn was exceptionally dry and warm until November 18; then,

suddenly, on the night of November 18/19, rain turned into sleet and snow, and the weather became cooler than normal and a consistent layer of snow formed. The 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 change in this part of Romania – BOGDAN et al. (2008); MARINICĂ & CHIMIŞLIU (2008); BOGDAN & MARINICĂ (2009); BOGDAN et al. (2010); MARINICĂ et al. (2010, 2011, 2012, 2013); BOGDAN et al. (2014). We will further analyze this exceptional climatic variability characteristic to the winter 2018-2019 at regional level in Oltenia and its consequences for crops, biotopes, economy and environment in general.

MATERIAL AND METHOD

For the achievement of the present study, we used the results of daily data processing based on special software from the forecasting process, the data archive of the N.A.M., the maps achieved during the operative activity and those provided by the international analysis and forecast centres, available online, as well as provided by N.A.M. Bucharest. We used Microsoft Office to draw up tables and charts. The paper analyses the climatic variability of the warm winter 2018-2019 in the southwest of Romania, based on the thermal and pluviometric regime of December 2018, January and February 2019 and the overall thermal and pluviometric regime of the winter 2018-2019. Effects on the environment and biotopes were also analysed.

RESULTS

1. a. The thermal regime of December 2018.

Monthly air temperature averages ranged from -0.7°C in Polovragi to 1.8°C in Drobeta Turnu Severin and their deviations from the multiannual averages were between -1.1°C in Târgu Logreşti and 0.7°C in Voineasa, determining the classification of the thermal types based on the Hellmann criterion as normal within almost the entire region except for a small area at Târgu Logreşti, where December was cool (CO) with a deviation that was very close to the lower limit of the normal (Table 1). *The monthly average air temperature* calculated for the entire region was 0.0°C, and its deviation from the normal was -0.14°C, which confirms that December 2018 was thermally normal as average for the entire Oltenia region. There were 14 days in which the daily air temperature averages for the whole region were positive and 17 days when they were negative (cold days). According to the daily average temperature for the entire region, the warmest day was December 23 with a daily average of 4.94°C, while the coldest day was December 1 with an average of -6.1°C. The *monthly minimum air temperature values* were recorded on December 1, 2, 3, and varied between -7.3°C in Drobeta Turnu Severin and -16.4°C in Bechet; their average for the entire region was -11.0°C. The *coldest morning* of December 2018, based on the average of the minimum temperatures calculated for the entire region, was registered on December 2 and it was -9.59°C. The *monthly maximum temperatures* were recorded on different dates (December 4, 5, 9, 10, 23 and 29) and ranged from 7.4°C in Voineasa to 14.6°C in Târgu Jiu; their average for the entire Oltenia region was 10.9°C. According to the daily averages of the maximum temperatures for the entire region, in December, only five days of winter were recorded. *The hottest day of December 2018*, based on the average of the maximum temperatures for the entire region, was December 23, when the average reached 10.2°C and *the coldest day* was December 1 with an average of -1.85°C. At *the soil surface, the minimum temperatures* were recorded mostly on December 1, 2 and 3 and were between -8.6°C in Apa Neagră and -16.4°C within the Oltenia Plain in Băileşti; their average for the entire region was -12.1°C. The maximum temperatures at the soil surface were registered on different dates (December 5, 9, 10, 23 and 28) and ranged between 7.2°C in Drăgăşani and 17.1°C in Băileşti and their average for the entire region was 12.0°C. There were frequent alternations of frost and thaw at the surface of the soil, and the vernalization[1] process was carried out during the cold periods of the month. The thermal regime specific to December installed in the last two days of November, when temperature dropped below 0.0°C. The minimum monthly temperatures were registered on November 30. The *frost units*[2] ranged from 16.7 in Drobeta Turnu Severin and 46.9 in Voineasa and their average for the entire region was 37.4°C. The heat units ranged from 8.9 at the southern limit of the mountain region in Voineasa and 80.5 in southwestern Oltenia, in Calafat; their average for the entire region was 36.2, only 1.2 lower than the frost units, which reflects a state of thermal balance between slightly cooler weather and slightly warmer weather compared to the normal, that is, ***a mild December month*** from the ***agrometeorological point of view***. The values of agrometeorological frost were insignificant. These thermal characteristics had a particular influence on vegetation and biotopes that, after the

[1] Vernalization represents the acquiring or acceleration of flowering capacity under the influence of low temperature exposure.

[2] The ***degree of winter bitterness*** in agrometeorology (winter type) is classified according to the sum of frost units (∑ of the differences between the daily minimum temperature values <-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 average temperatures <0°C, in the period November-March; A ***frost day*** is the day with the average temperature ≤ 0°C; The ***active temperature are those ≥0°C,*** while the temperature of the biological minimum is 0°C. A ***winter day*** is a day with the air maximum temperature < 0°C. ***Heat units*** (∑ of daily average temperatures ≥ 0°C). From the public point of view with regard to weather forecast, ***the notion of frost is associated with temperature values of ≤ -10°C***. Thus, ***frost*** defined in terms of 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).

cooling registered by the end of November and the beginning of December, in the warm days of December, slowly resumed vegetative activity and biotic processes within biocoenoses[3], 0.0°C being the temperature of the biological minimum.

Table 1. Air temperature regime within Oltenia and the minimum and maximum temperature values at the soil surface in December 018 (N XII = December normal values calculated for the period 1901-1990, M XII = monthly averages of December 2018; Δ=M-N = temperature deviation, CH = Hellmann criterion).

No	Meteorological station	Hm	N XII	M XII	Δ=M-N	CH	Min T air		Max T air		Min T soil		Max T soil	
							(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
1	Dr. Tr. Severin	77	1.4	**1.8**	0.4	**N**	***-7.3***	1	13.0	9	-8.8	1	14.6	9
2	Calafat	66	1.0	1.5	0.5	**N**	-10.2	2	13.6	23	-14.8	2	14.4	28
3	Bechet	65	0.4	0.4	0.0	**N**	***-16.4***	1	12.3	23	-14.8	1	9.8	9
4	Băileşti	56	0.4	0.5	0.1	**N**	-13.0	1	11.1	9	***-16.4***	1	**17.1**	6
5	Caracal	112	-0.1	0.0	0.1	**N**	-11.5	2;3	9.5	9	-12.2	2	9.6	9
6	Craiova	190	0.1	-0.3	-0.4	**N**	-10.0	2	9.7	9	-10.5	3	13.8	9
7	Slatina	165	0.3	-0.5	-0.8	**N**	-10.4	2	9.0	29	-11.8	3	10.2	23
8	Bâcleş	309	-0.4	-0.2	0.2	**N**	-10.5	2	9.9	9	-	-	-	-
9	Tg. Logreşti	262	0.1	-1.0	***-1.1***	**CO**	-10.8	2	10.3	10	-15.5	26	12.8	9
10	Drăgăşani	280	0.6	0.1	-0.5	**N**	-7.9	2;26	10.1	29	-9.2	3	***7.2***	9
11	Apa Neagră	250	0.1	-0.8	-0.9	**N**	-11.0	13	12.9	5	***-8.6***	28	8.7	9
12	Tg. Jiu	210	0.1	-0.3	-0.4	**N**	-8.1	3	**14.6**	23	-8.8	31	14.2	10
13	Polovragi	546	0.1	***-0.7***	-0.8	**N**	-12.2	1	9.6	5	-14.2	1	12.3	5
14	Rm. Vâlcea	243	0.5	0.1	-0.4	**N**	-8.1	2	11.6	5	-11.9	26	11.0	5
15	Voineasa	587	-1.9	-1.2	**0.7**	**N**	-12.5	1	***7.4***	23	-	-	-	-
16	Parâng	1585	-3.7	-	-	**-**	-15.7	1	9.2	24	-	-	-	-
	Average for Oltenia	-	0.18	0.04	-0.14	**N**	-11.0	-	10.9	-	-12.1	-	12.0	-
17	Ob. Lotrului	1404	-4.9	-4.1	0.8	**N**	-19.7	14	4.4	4	-	-	-	-

(Source: processed data from the N.A.M. Archive)

The *graphs of the variation of the parameters* characterizing air temperature (average of daily minimum values, daily average and average of daily maximum values, all calculated for the entire region) in December 2018 presented significant increasing linear trends (Fig. 1).

The statistical analysis of the evolution of average air temperature in December during the last 58 years (1961-2018) leads to the following conclusions (Table 2): The ***coldest December months*** in the last 58 years were recorded in: ***1998*** (CL, with an average of ***-4.03°C***), ***1977*** (CL, with an average of -3.66°C), ***2001*** (CL, with an average of - 3.59°C), ***1962*** (CL, with an average of -3.31°C), ***2002*** (CL, with an average of -3.04°C), ***1991*** (CL, with an average of -2.39°C) and ***1963*** (CL, with an average -2.16). ***December 1998 was the coldest first winter month in the last 58 years, being classified as cold (CL), according to the temperature values registered at the level of 2m above the ground*** (MARINICĂ & MARINICĂ, 2012; 2016). As a result, ***in the last 58 years, there was only one December month with a monthly average below -4.00°C (1998)***. Most of the months colder than the normal were recorded before 1999 (12 months out of a total of 16 months). The warmest December months in the last 58 years were recorded in the years: ***2015*** (VW, with a general average of 5.19°C), ***1979*** (W, with a general average of 3.21°C), ***1982*** (W, with a general average of 3.08°C), ***2017*** (W, with a general average of 2.74°C), ***1971*** (W, with a general average of 2.37°C), ***1985*** (W, with a general average of 2.17°C). Most *December months were thermally normal*, 26 cases (44.8%) and the number of warm and cold months was the same, 16 cases (namely 27.6%); there was registered only one very warm (VW) month in the warmest year in the history of climate observations in Romania (2015 with the annual average for the entire Romania of 11.72°C, and at the regional level, in Oltenia, the annual average was 1.93°C). No December months were very cold. The number of warmish December months (WS) was 10, while the number of cool months (CO) was 9 months. Most December months warmer than the normal have been recorded since 1999 (10 months out of 16). The *increase trend of the average monthly temperature* over the last 58 years, calculated for the entire region, is evident, with a significant increase rate (0.0168) (Fig. 2).

December 2015 was the warmest first winter month (Table 2) and the only very warm (VW) month for the entire Oltenia region during the observation period. ***The monthly average of 5.19°C for the entire Oltenia region, registered in December 2015, is an absolute climatic record for December, recorded in the warmest year in Romania so far***. The average December temperature, calculated for the entire region over the past 58 years, was 0.16°C. As a result of the increase in the average monthly temperature, the frequency, duration and intensity of cold waves in December declined considerably. Climate warming is thus demonstrated also at the regional level, and the continuation of this climate process in 2018 (with an average of -0.04°C) was done under the conditions of minimum solar activity and in the absence of the El Niño climate process.

[3] The term ***biocoenosis*** (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 (*zoocoenosis)* 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 biocoenosis was proposed by Karl Möbius in 1877 (http://en.wikipedia.org/wiki/Biocenoz%C4%83).

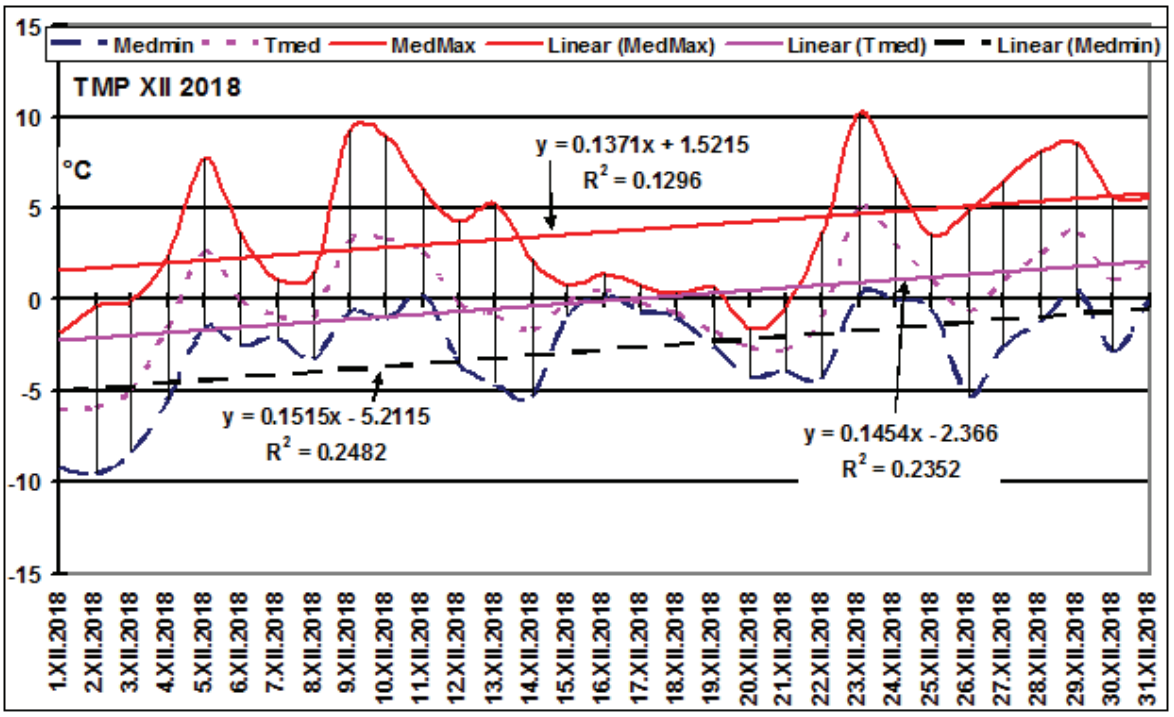

Figure 1. Variation of the parameters characteristic to air temperature (average of daily minimum values, daily average and average of daily maximum values calculated for the entire region) in December 2018. (Source: processed data from the N.A.M. Archive).

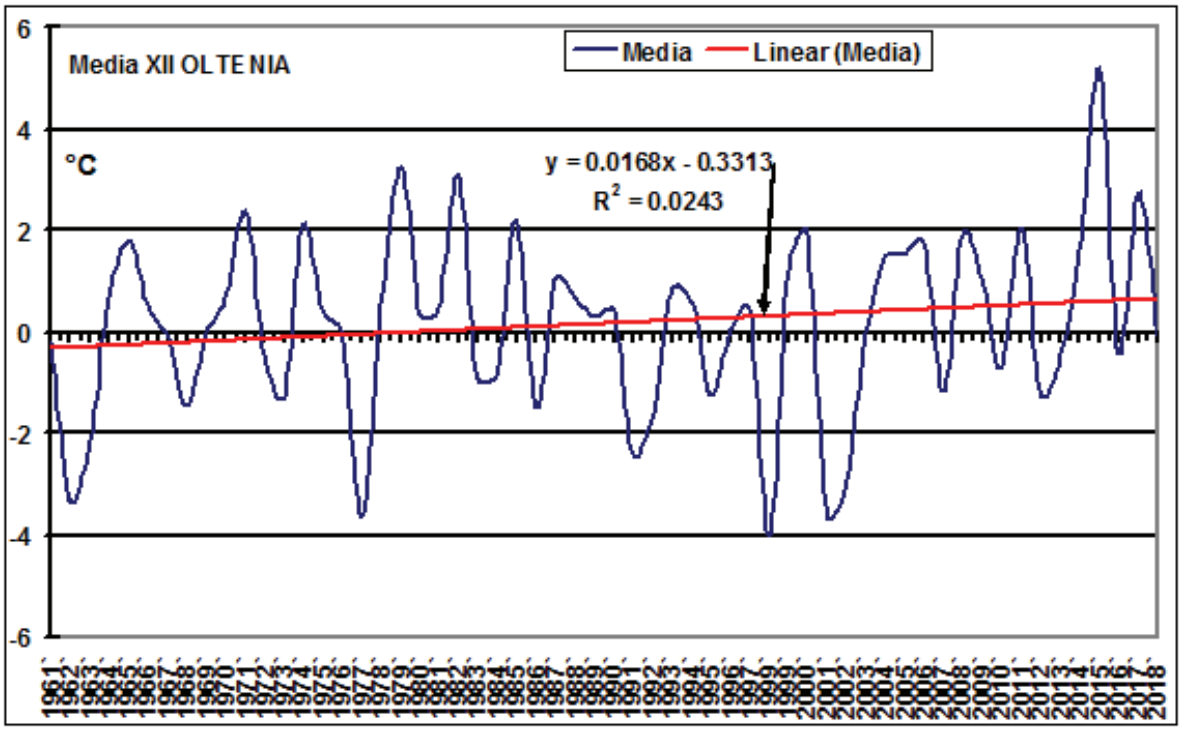

Figure 2. Variation of the air average temperature calculated for the entire region Oltenia in December in the last 58 years (1961-2018).

1. b. The pluviometric regime of December 2018. The *monthly rainfall amounts* ranged between 17.1 l/m^2 at Bechet and 98.2 l/m^2 at Râmnicu Vâlcea. Their percentage deviations from the normal values ranged from -52.9% at Bechet and 112.6% at Râmnicu Vâlcea, determining the classification of pluviometric types from excessively dry (ED) in Bechet to excessively rainy (ER) in the Oltenia Hills in Drăgăşani, in the Subcarpathian Depression in Polovragi, in the Olt Corridor in Râmnicu Vâlcea and in the mountain area in Parâng (Table 3).

Table 2. Thermal classification of December months within Oltenia in the last 58 years. (**AvgT** = December average temperature calculated for the entire Oltenia region with altitudes below 600 m (°C), Type = thermal classification of the month according to Hellmann criterion[4], Cold = no. of cold months and their percentage, Normal = no. of normal months and their percentage, Warm = no. of warm months and their percentage, EC= excessively cold, VC = very cold, CL = cold, CO = cool, N = normal, WS = warmish, W = warm, VW = very warm, EW = excessively warm).

No	Year	AvgT	Type	No	Year	AvgT	Type	No	Year	AvgT	Type	No	Year	AvgT	Type
1	1961	-0.17	**N**	17	1977	-3.66	**CL**	33	1993	0.81	**N**	49	2009	1.00	**N**
2	1962	-3.31	**CL**	18	1978	0.53	**N**	34	1994	0.61	**N**	50	2010	-0.72	**N**
3	1963	-2.16	**CL**	19	1979	3.21	**W**	35	1995	-1.24	**CO**	51	2011	2.05	**WS**
4	1964	0.68	**N**	20	1980	0.34	**N**	36	1996	0.05	**N**	52	2012	-1.22	**CO**
5	1965	1.81	**WS**	21	1981	0.48	**N**	37	1997	0.47	**N**	53	2013	-0.42	**N**
6	1966	0.54	**N**	22	1982	3.08	**W**	38	***1998***	***-4.03***	**CL**	54	2014	1.61	**WS**
7	1967	-0.11	**N**	23	1983	-0.90	**CO**	39	1999	1.21	**WS**	55	**2015**	**5.19**	**VW**
8	1968	-1.44	**CO**	24	1984	-0.82	**CO**	40	2000	1.95	**WS**	56	2016	-0.40	**N**
9	1969	-0.03	**N**	25	1985	2.17	**W**	41	2001	-3.59	**CL**	57	2017	2.74	**W**
10	1970	0.69	**N**	26	1986	-1.48	**CO**	42	2002	-3.04	**CL**	58	2018	-0.04	**N**
11	1971	2.37	**W**	27	1987	1.01	**N**	43	2003	0.00	**N**		Media	0.16	**N**
12	1972	-0.43	**N**	28	1988	0.70	**N**	44	2004	1.45	**WS**		Cold	16	27.6%
13	1973	-1.26	**CO**	29	1989	0.28	**N**	45	2005	1.55	**WS**		Normal	26	44.8%
14	1974	2.12	**WS**	30	1990	0.41	**N**	46	2006	1.80	**WS**		Warm	16	27.6%
15	1975	0.37	**N**	31	1991	-2.39	**CL**	47	2007	-1.19	**CO**				
16	1976	-0.01	**N**	32	1992	-1.61	**CO**	48	2008	1.90	**WS**				

(Source: processed data from the N.A.M. Archive)

Within the Oltenia Plain, December 2018 was characterized by deficit and, in the Bechet area, dry time continued from August 1, 2018 until March 8, 2019. *The average monthly rainfall amount* for the entire Oltenia region was 58.9 l/m^2 and its percentage deviation from the normal was 16.8%, which, according to the Hellmann criterion, determined the classification of the month as a little rainy month (LR). There was only one interval with significant rainfalls between December 14 and 18, and here we mention December 14, 15, 16 when the average rainfall amount for the entire region was 11.0 l/m^2 (on December 14), 15.0 l/m^2 (on December 15) and 20.7 l/m^2 (on December 16) respectively. In December, rainfall was in the form of rain, sleet and snow. The *snow layer* formed on the night of November 28 / 29 slowly melted in the interval December 1-5 and, on the night of December 14-15, it snowed again and the new layer reached a maximum thickness of 6 cm in Calafat and Râmnicu Vâlcea and 45 cm in Apa Neagră (Padeş) in Gorj County.

Table 3. Rainfall amounts registered in the winter 2018-2019 (Σ) compared to the normal[5] values (N); Δ%=percentage deviation from the normal, CH= Hellmann criterion.

No	Meteorological station	Hm	December 2018				January 2019				February 2019			
			ΣXII	**N**	**Δ%**	**CH**	**Σ I**	**N**	**Δ%**	**CH**	**ΣII**	**N**	**Δ%**	**CH**
1	Dr. Tr. Severin	77	45.7	61.2	-25.3	**D**	98.5	51.4	91.6	**ER**	31.7	47.9	-33.8	**VD**
2	Calafat	66	23.5	45.5	-48.4	**VD**	68.5	40.4	69.6	**ER**	10.1	38.0	-73.4	**ED**
3	Bechet	65	***17.1***	36.3	***-52.9***	**ED**	20.4	33.5	-39.1	**VD**	12.2	34.8	-64.9	**ED**
4	Băileşti	56	26.0	46.8	-44.4	**VD**	57.7	38.5	49.9	**VR**	11.3	36.1	-68.7	**ED**
5	Caracal	112	42.5	39.5	7.6	**N**	48.6	34.7	40.1	**VR**	14.6	34.5	-57.7	**ED**
6	Craiova	190	59.6	41.8	42.6	**VR**	65.2	37.5	73.9	**ER**	17.2	30.4	-43.4	**VD**
7	Slatina	165	46.2	42.8	7.9	**N**	59.4	36.0	65.0	**ER**	14.0	38.4	-63.5	**ED**
8	Bâcleş	309												
9	Tg. Logreşti	262	64.9	44.8	44.9	**VR**	101.8	35.9	183.6	**ER**	24.9	41.0	-39.3	**VD**
10	Drăgăşani	280	71.1	44.6	59.4	**ER**	81.9	34.1	140.2	**ER**	12.1	35.4	-65.8	**ED**
11	Apa Neagră	250	73.1	82.3	-11.2	**LD**	**164.8**	70.9	132.4	**ER**	24.2	66.4	-63.6	**ED**
12	Tg. Jiu	210	79.1	64.0	23.6	**R**	119.0	53.9	120.8	**ER**	**32.8**	52.0	-36.9	**VD**
13	Polovragi	546	85.6	56.1	52.6	**ER**	103.6	48.9	111.9	**ER**	16.9	48.4	-65.1	**ED**
14	Rm. Vâlcea	243	**98.2**	46.2	**112.6**	**ER**	89.6	35.5	152.4	**ER**	9.1	38.4	-76.3	**ED**
15	Voineasa	587												
16	Parâng	1585	92.5	54.6	69.4	**ER**	84.5	57.7	46.4	**VR**	32.0	47.7	-32.9	**VD**
	Average for Oltenia	-	58.9	50.5	16.8	**LR**	83.1	43.5	91.1	**ER**	16.9	42.3	-60.0	**ED**
17	Ob. Lotrului	1404	173.6				107.0				30.6			

(ER=excessively rainy; VR=very rainy, R=rainy, LR=little rainy, N=normal, LD=little dry, VD=very dry, ED=excessively dry) (Source: processed data from the N.A.M. Archive)

The *warming* of the weather from December 22-31 caused the melting of the snow layer in Oltenia Plain, but in the hilly area, especially in the Gorj County, the Subcarpathians and the mountain area, it persisted until February 11, 2019, with various thicknesses. In the area sheltered by the Carpathian curvature cold air persisted and the

[4] The comparison was made with December multiannual average for the last century, average calculated for the whole region (1901-1990). ***The comparison with the statistical median is irrelevant***, as the median has no connection to the dataset other than that the value is positioned at the middle of the dataset arranged ascending order.

[5] Voineasa and Bâcleş meteorological station cannot be taken into account as they do not have complete pluviometric data series for the cold season.

snow layer was maintained from December 15 until February 11 (59 days), while in the south of Gorj County, the snow layer melted and reappeared several times in the winter of 2018-2019. In Târgu Logreşti, on the morning of December 11, the snow layer was 7 cm thick, but it melted until the evening. The curvature of the Southern Carpathians in the sector between the Almăj and Parâng Mountains, in interaction with air circulation from the western sector (which usually causes warming in Oltenia), has a sheltering effect, similar to the effect of an airplane wing, keeping cold air above Gorj County, an area in the northeast of Mehedinţi County and an area in the northwest of Vâlcea County. This explains the lower monthly average temperatures in Gorj, as well as the lower spring arrival indexes in this area. Cold air advections in this area, from the east and northeast, are not prevented by any orographic barrier and penetrate the entire Oltenia. At the end of December, on December 29, for the crop of autumn wheat, the *water supply* on the soil profile of 0-100 cm was satisfactory, close to the optimal or within optimal limits, in most of Oltenia (N.A.M.)

2. a. The thermal regime of January 2019.

The monthly air temperature averages ranged between -2.9°C in Voineasa and 0.9°C in Drobeta Turmu Severin, and their deviations from the multiannual averages of the last century ranged between 0.4°C in Apa Neagră (Padeş) and 2.3°C in Calafat, which according to Hellmann criterion, corresponds to normal (N), within small areas such as Târgu Logreşti and Apa Neagră, and warm (W) in Drobeta Turmu Severin, Calafat and Caracal. *Warmish time* (WS) had the largest spatial-temporal extension in January (Table 4). *The monthly average air temperature* calculated for the entire Oltenia region was -1.0°C and its deviation from the average of the last century (considered normal) was 1.6°C, which confirms that January 2019 was warmish (Ws) in average for the entire Oltenia region.

Table 4. Air temperature regime within Oltenia and the minimum and maximum temperature values at the soil surface in January 2019 (N I = January normal values calculated for the period 1901-1990, M I = monthly averages of January 2019; Δ=M-N = temperature deviation, CH = Hellmann criterion).

No	Meteorological station	Hm	N I	M I	Δ=M-N	CH	Min T air		Max T air		Min T soil		Max T soil	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr.Tr. Severin	77	-1.1	**0.9**	2.0	**W**	**-9.3**	8	**13.5**	17	**-10.2**	5	**13.7**	17
2	Calafat	66	-1.8	0.5	**2.3**	**W**	**-11.1**	14	**14.3**	17	**-12.5**	12	**15.4**	17
3	Bechet	65	-2.2	-0.5	1.7	**WS**	**-12.2**	8	**11.1**	17	**-11.4**	5	**14.8**	31
4	Băileşti	56	-2.3	-0.6	1.7	**WS**	**-12.2**	14	**10.9**	17	**-17.6**	13	**12.1**	3
5	Caracal	112	-2.9	-0.8	2.1	**W**	**-12.1**	8	**9.4**	17	**-13.0**	9	**8.9**	31
6	Craiova	190	-2.6	-1.0	1.6	**WS**	**-11.7**	5;8	**11.0**	17	**-11.8**	5	**15.2**	31
7	Slatina	165	-2.4	-1.2	1.2	**WS**	**-12.7**	8	**9.9**	18	**-15.8**	8	**5.0**	30
8	Bâcleş	309	-3.0	-1.1	1.9	**WS**	**-10.7**	8	**9.2**	17	**-**	-	**-**	-
9	Tg. Logreşti	262	-2.7	-2.1	0.6	**N**	**-16.5**	8	**10.1**	17	***-19.4***	8	**5.8**	17
10	Drăgăşani	280	-2.2	-0.5	1.7	**WS**	**-9.7**	8	**9.9**	18	**-11.8**	8	**18.0**	30
11	Apa Neagră	250	-2.6	-2.2	***0.4***	**N**	***-17.3***	12	***8.2***	16	**-18.4**	13	**6.0**	17
12	Tg. Jiu	210	-2.6	-1.5	1.1	**WS**	**-13.7**	13	**12.5**	17	**-14.9**	13	***4.5***	17
13	Polovragi	546	-3.2	-1.6	1.6	**WS**	**-12.2**	8	**7.9**	18	***-19.4***	8	**7.2**	15
14	Rm. Vâlcea	243	-2.2	-0.5	1.7	**WS**	**-11.1**	8	**9.6**	16	**-16.6**	13	**8.6**	18
15	Voineasa	587	-4.7	***-2.9***	1.8	**WS**	**-16.9**	5	**8.3**	17	**-**	-	**-**	-
16	Parâng	1585	-	-	-	**-**	**-17.1**	5	**3.3**	31	**-**	-	**-**	-
	Average for Oltenia	-	-2.6	-1.0	1.6	**WS**	-12.6	-	10.4	-	**-14.8**	-	**10.4**	-
17	Ob. Lotrului	1404	-6.2	-5.9	0.3	**N**	**-24.0**	5	**5.8**	29	**-**	-	**-**	-

(Source: processed data from the N.A.M. Archive)

Most of *the monthly minimum air temperatures* were registered on January 8 and ranged between -17.3°C in Apa Neagră and -9.3°C in Drobeta Turmu Severin and their average for the entire region was -12.6°C. Most of *the monthly maximum air temperatures* were registered on January 17 and were between 8.2°C in Apa Neagră and 14.3°C in Calafat, and their average for the entire region was 10.4°C. *Frost units* ranged between 11.3 in Drobeta Turmu Severin and 98.6 at Voineasa, and their average for the entire region was 49.7. Most frost units were registered in the interval January 1-14. According to the general average of the daily maximum temperatures for the entire region, there were 4 winter days in January. Vernalization continued especially in the period January 1-14. *Heat units* were between 8.8 in Voineasa and 40.3 in Drobeta Turmu Severin, and their average for the entire region was 19.0. From an agrometeorological point of view, these values mean a ***mild winter month***. Most heat units were registered in the interval January 15-31. According to the daily temperature average for the entire region, *the coldest day* was January 8, with an average of -7.1°C, and the warmest day was January 31, with the average of 2.5°C.

At *the surface of the soil, the monthly minimum temperatures* were registered on January 5, 8, 9, 12 and 13 and ranged between -10.2°C in Drobeta Turmu Severin on January 5 and -19.4°C in Târgu Logreşti and Polovragi on January 8 and their average for the entire region was -14.8°C. *At the surface of the soil, the monthly maximum temperatures* were registered on January 3, 15, 17, 18, 30 and 31 and ranged between 4.5°C in Târgu Jiu on January 17 and 18.0°C in Drăgăşani on January 30. Their average for the entire region was 10.4°C, equal to the average of the maximum monthly air temperature values. *The graphs of the variation of the parameters* characterizing air temperature (average of daily minimum values, daily average and average of daily maximum values, all calculated for the entire region) in January 2019 had markedly increasing linear trends (Fig. 3).

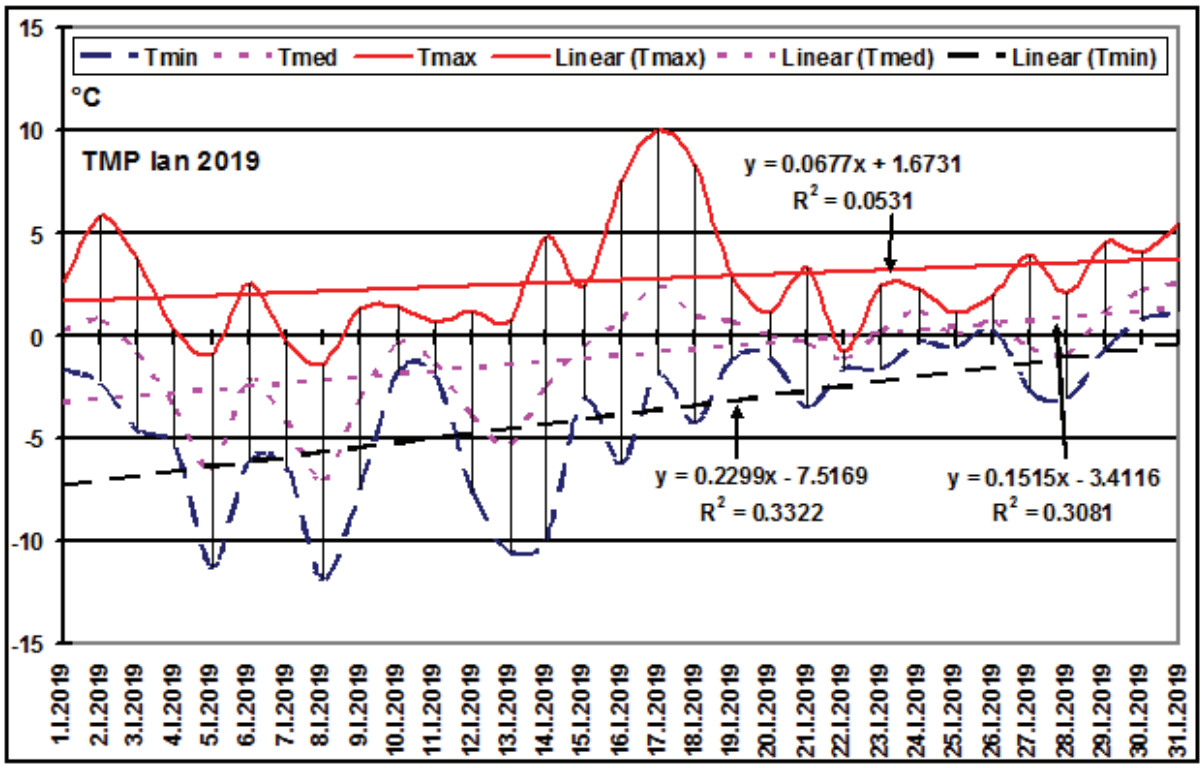

Figure 3. Variation of the parameters characteristic to air temperature (average of daily minimum values, daily average and average of daily maximum values calculated for the entire region) in January 2019. (Source: processed data from the N.A.M. Archive).

2. b. The pluviometric regime of January 2019. *The monthly rainfall amounts* ranged between 20.4 l/m^2 in Bechet and 164.8 l/m^2 in Apa Neagră (Padeş) and their percentage deviations from the multiannual averages calculated for the last century ranged from -39.1% at Bechet (the only one area with negative deviation) and 183.6% in Târgu Logreşti which, according to Hellmann criterion, makes January 2019 excessively rainy (ER) within most of the region. We notice monthly amounts ≥ 100.0 l/m^2 in 5 meteorological stations (Tg. Logreşti 101.8 l/m^2, Polovragi 103.6 l/m^2, Obârşia Lotrului 107.0 l/m^2, Târgu Jiu 119.0 l/m^2, Apa Neagră 164.8 l/m^2) and a value close to 100.0 l/m^2 in Drobeta Turnu Severin (98.5 l/m^2). *The average of the monthly rainfall amounts* calculated for the entire region was 83.1 l/m^2 and its percentage deviation from the normal was 91.1%, which confirms that January 2019 was on average excessively rainy (ER) for the entire Oltenia region (Table 3).

Precipitations were predominantly solid and three intervals with significant amounts were registered: January 9-10, January 22-26 and January 29-30 totalizing 9 days. The highest amount was registered on January 24, 2019, when the average calculated for the entire region was 17.1 l/m^2 and the maximum amount of rainfall recorded in 24 hours was 39.3 l/m^2 in Râmnicu Vâlcea. The *snow layer* in January in the Oltenia Plain gradually increased starting with January 4 and reached the maximum thickness on January 11, when it ranged between 6 cm in Slatina and 15 cm in Craiova. In the hilly area and the Subcarpathians, it persisted throughout the month and reached the maximum thickness on January 23 with values between 10 cm in Drăgăşani and 49 cm in Apa Neagră. The reduction of the snow layer started on January 28 as heating process began. In the mountain area from northern Oltenia, the thickness of the snow layer reached 142 cm in Obârşia Lotrului on January 26, while at the Parâng Peak, it reached 102 cm on January 31. *At the level of the entire country*, the snow layer was consistent, reaching 110 cm in Cavnic (Maramureş County) on January 15; in the area of the settlements Şuior, Firiza, Chiuzbaia, Baiuţ located close to the mountains, it reached over 120-130 cm, while the maximum thickness of 228 cm was reached in Cuntu, in the mountain area, on January 16. In the *Southern Hemisphere*, January is the peak summer month, and in Australia[6], in Tarcoola, the absolute thermal maximum of 48.7°C was registered (on the same date, January 16), in Port Augusta the absolute thermal maximum reached 49.5°C and in Adelaide 46.6°C. On the same day, in Russia, at Ikki-Ambar (Yakuția), the temperature dropped to -56.0°C. In January, *the snow layer in Europe* exceeded 2 m in some areas in Austria and southern Germany blocking the rail and air traffic (January 14); in Germany, on this date, a ***violet warning for violent snows*** was issued. The violet warning (in Germany[7]) means the deposition of a layer of fresh snow of at least 1 m in 24 hours (in Romania there is no

[6] January 2019 was the hottest month in the history of meteorological records in Australia (Australian Bureau of Meteorology). The average temperature recorded for the whole Australia in January has exceeded 30°C for the first time since the measurements began in 1910 (BMA and Agerpres) (https://www.profit.ro/stiri/life/luna-ianuarie-2019-cea-mai-calda-din-istoria-australiei-18835783).

[7] In Romania, so far, there ***is no violet code*** for any meteorological phenomenon. In Romania, according to operational regulations and laws, the code indicating ***maximum danger*** in case of meteorological phenomena is the ***orange*** one.

violet warning for any phenomenon). Heavy snowfalls, blizzards and intense frost were recorded in the North American continent and the media said that in some areas of Mars it was warmer than in some areas in North America (https: //www.groundzeromedia.org/2-14-19-apocalypse-theorem/). As a result of the abundant rainfall registered on January 31, in the winter wheat crop, the moisture reserve on the soil depth of 0-100 cm will was close to optimal or within optimal limits, within most of Oltenia (N.A.M.).

3. a. The thermal regime of February 2019. The monthly air temperature averages were between 0.1°C at Voineasa and 4.0°C a in t Drobeta Turnu Severin, and their deviations from the normal values were between 1.6°C in Apa Neagră and 4.3°C in Drăgăşani, which, according to the Hellmann criterion, shows that February was warm (W) within most of Oltenia (Table 5). The *monthly average air temperature* calculated for the entire Oltenia region was 2.7°C (the highest monthly average temperature of the winter) and its deviation from the normal was 3.2°C, which confirms that February was warm on average for the entire Oltenia region.

Table 5. Air temperature regime within Oltenia and the minimum and maximum temperature values at the soil surface in February 2019 (N I = February normal values calculated for the period 1901-1990, M I = monthly averages of February 2019; Δ=M-N = temperature deviation, CH = Hellmann criterion).

No	Meteorological Station	Hm	N II	M II	Δ=M-N	CH	Min T air		Max T air		Min T soil		Max T soil	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr.Tr. Severin	77	0.9	**4.0**	3.1	**W**	**-11.1**	24	**17.1**	20	**-12.5**	24	**26.2**	28
2	Calafat	66	0.4	3.9	3.5	**W**	**-11.0**	24	**18.5**	18	**-19.0**	24	**16.8**	4
3	Bechet	65	-0.1	3.0	3.1	**W**	**-10.1**	24	**17.7**	20	**-4.2**	23	**19.4**	28
4	Băileşti	56	-0.1	2.9	3.0	**W**	**-11.5**	24	**17.6**	20	**-18.4**	24	**23.8**	18
5	Caracal	112	-0.7	3.5	4.2	**W**	**-7.6**	24	**17.5**	20	**-10.4**	24	**16.2**	19
6	Craiova	190	-0.4	3.2	3.6	**W**	**-10.4**	24	**17.6**	20	**-13.2**	24	**25.2**	20
7	Slatina	165	-0.2	3.2	3.4	**W**	**-9.4**	24	**18.2**	20	**-11.8**	24	**12.2**	4
8	Bâcleş	309	-0.9	2.7	3.6	**W**	**-10**	24	**15.9**	20	-	-	-	-
9	Tg. Logreşti	262	-0.7	1.3	2.0	**W**	**-16.7**	24	**17.0**	18	**-19.5**	24	**22.5**	18
10	Drăgăşani	280	-0.2	4.1	**4.3**	**W**	**-9.3**	24	**18.5**	20	**-11.4**	24	**13.3**	4
11	Apa Neagră	250	-0.6	1.0	***1.6***	**WS**	***-17.2***	24	**16.8**	18	**-18.5**	24	***11.1***	18
12	Tg. Jiu	210	-0.4	2.0	2.4	**W**	**-13.4**	24	**17.9**	20	**-14.5**	24	**20.5**	21
13	Polovragi	546	-1.4	2.1	3.5	**W**	**-12.9**	24	**15.5**	18	***-20.9***	24	**19.7**	28
14	Rm. Vâlcea	243	0.0	3.7	3.7	**W**	**-10.1**	24	**17.9**	18	**-13.8**	24	**20.4**	21
15	Voineasa	587	-2.5	***0.1***	2.6	**W**	**-11.0**	25	***14.8***	20	-	-	-	-
16	Parâng	1585	-	-	-	-	**-17.2**	23	**10.3**	18	-	-	-	-
	Average for Oltenia	-	-0.5	2.7	3.2	**C**	**-11.8**	-	**16.8**	-	**-14.5**	-	**19.0**	-
17	Ob. Lotrului	1404	-5.5	-4.2	1.3	**CL**	**-22.5**	24	**11.0**	18	-	-	-	-

(Source: processed data from the N.A.M. Archive)

The minimum monthly air temperatures were registered atypically, during the last pentad of the month, on February 24, and were between -17.2°C in Apa Neagră and -7.6°C in Caracal; the average for the entire region was of -11.8°C. The *maximum monthly air temperatures* were registered on February 18 and 20 and ranged between 14.8°C in Voineasa and 18.5°C in Calafat and Drăgăşani and their average for the entire region was 16.8°C, being the highest average of the monthly maximum temperatures in the winter 2018-2019. The *agrometeorological frost* was insignificant, and the *frost units*, registered in the interval February 23-25, ranged from 8.5 in Tr. Severin and 23.1 in Târgu Logreşti with an average of 14.7 for the entire region. The *heat units* were registered throughout the month except for the interval 23-25 and were between 25.6 in Voineasa and 126.1 in Drăgăşani; their average for the entire region was 93.4, exceeding the frost units. All this shows that ***February was a mild winter month*** from the agrometeorological point of view. *At the surface of the soil,* most of the minimum monthly temperatures were registered during the cooling period, at the end of February, on 24 February, and were between -20.9°C in Polovragi and -4.2°C in Bechet; their average for the whole region was -14.5°C, being the second average in descending order from this winter after December. The monthly maximum values at the surface of the soil were registered at different dates and ranged from 11.1°C in Apa Neagră and 26.2°C in Drobeta Turnu Severin, and their average for the entire region was 19.0°C, being the highest of the winter.

The only intense cooling interval of February was between 23 and 25. In Oltenia, the weather cooled quickly on the night of February 22/23. The rain that started in the evening, after a warm day (maximum temperatures of 8-12°C on February 22 and early morning rain), quickly turned into snow and the wind intensified. The blizzard recorded between the 9 and 12 p.m. was so intense that it was not possible to distinguish the falling snow from the blown away snow and visibility was particularly low. During the night of February 22/23, snow falling was accompanied by blizzard on extended areas. The wind intensified, the peak gust reaching speeds of ≥ 80km/h between 9 and 12 p.m., then the sky cleared up and the weather continued to cool. A snow layer with a thickness between 4 cm in Calafat and Bechet and 23 cm in Târgu Jiu formed, but it that melted until February 27. In Dobrogea, in Jurilovca, the peak gust was of 130 km/h and 115 km/h in Mahmudia. For Oltenia, ***this was the only blizzard during this winter***. The charts of the variation of the air temperature (average daily, daily average and daily peak average values all calculated for the entire region) in February 2019 had a linearly significant upward trend for daily and decreasing daily and maximum daily and minimum

daily temperatures (Fig. 4), aspect due to the cooling of the weather in the period 23-25. *The graphs of the variation of the parameters* characterizing air temperature (average of daily minimum values, daily average and average of daily maximum values, all calculated for the entire region) in February 2019 had markedly increasing linear trends in case of daily maximum temperatures and decreasing in case of daily averages and minimum temperature averages (Fig. 4), due to the weather cooling characteristic to the interval February 23-25.

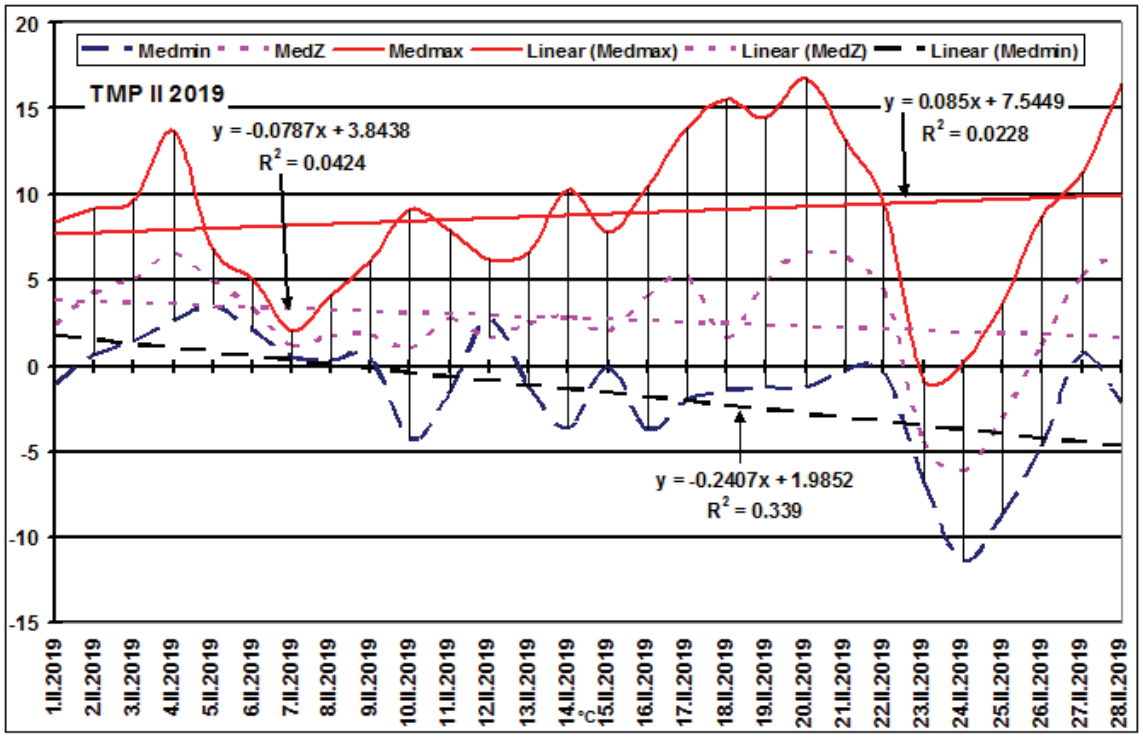

Figure 4. Variation of the parameters characteristic to air temperature (average of daily minimum values, daily average and average of daily maximum values calculated for the entire region) in February 2019.

3. b. The pluviometric regime of February 2019. The monthly rainfall amounts in February were between 9.1 l/m^2 in Râmnicu Vâlcea and 32.8 l/m^2 in Târgu Jiu and their percentage deviations from the normal were between -76.3% in Râmnicu Vâlcea and -36.9% in Tg. Jiu; according to the Hellmann criterion, February was dry with classifications of pluviometric types from very dry (VD) to excessively dry (ED) in all the weather stations (Table 3). The average monthly rainfall amount calculated for the Oltenia region was 16.9 l/m^2 and its percentage deviation from the normal was 60.0%, which confirms that February was an excessively dry (ED) month in the entire Oltenia region. There was only one short interval with significant rainfalls on the night of February 22/23, 2019 with an average of 8.8 l/m^2 for the whole region.

4. The seasonal climatic characteristics of the winter 2018-2019. *The seasonal air temperature averages* were between -1.3°C in Voineasa and 2.2°C in Drobeta Turnu Severin and their deviations from the normal values ranged from 0.3°C in Apa Neagră and 2.1°C in Calafat and Caracal; thus, according to Hellmann criterion, the winter 2018-2019 was warm (W) throughout the region except for two areas, Târgu Logresti and Apa Neagră, where it was thermally normal (N) (Table 6). The *seasonal average* of the air temperature calculated for the entire region was 0.6°C and its deviation from the normal was 1.55°C, which confirms the characteristic of warm winter (W) for the entire Oltenia region. The *seasonal rainfall amounts* ranged between 49.7 l/m^2 in Bechet, in the extreme south of Oltenia, and 262.1 l/m^2 in Apa Neagră, in the area of the Subcarpathian depressions; their percentage deviations from the seasonal normal values were between -52.5% in Bechet and 69.3% in Râmnicu Vâlcea, determining, according to Hellmann criterion, the classification of the pluviometric types in Oltenia from excessively dry (ED) in Bechet area to excessively rainy (ER) in the hilly area at Târgu Logreşti and in the Olt Corridor in Drăgăşani and Râmnicu Vâlcea. *The average of the seasonal rainfall amounts* calculated for the entire Oltenia region was 158.9 l/m^2 and its percentage deviation from the normal was 15.8%, which, according to the Hellmann criterion, means that on average the winter 2018-2019 was a little rainy (LR).

DISCUSSIONS

The coldest interval of the winter 2018-2019 was January 9-14, when there were registered the minimum temperature values for January, which, with few exceptions, also represent the minimum values for the entire season. During this interval, there were 4 days (5, 8, 13 and 14) when the average daily minimum temperature calculated for the entire region was ≤ -10°C, namely, there were 4 frost nights in Oltenia. We will analyse the synoptic situation that triggered this severe

cooling of the weather during the maximum phase that lasted for 4 days. Within 24 hours, from the morning of January 4 until the morning of January 5, the average of the daily minimum temperatures calculated for the entire Oltenia region decreased by 5.87°C (from -5.47°C on the morning of January 4 to -11.34°C on the morning of January 5).

Table 6. Air temperature and rainfall regime in the winter of 2018-2019 (Hm = Hm = altitude of the meteorological station, W`18-`19= average temperature values in the winter 2018-2019 (°C), NW = normal values of the seasonal averages winter temperature (°C), Δ = W-N = deviation of temperatures from the normal (°C) CrH = Hellmann criterion; SW = sum of rainfall in the winter 2018-2019 (l/m^2), NW = normal rainfall amounts during winter (l/m^2), Δ = S-N= deviations from the normal (l/m^2), Δ% = percentage deviations from the normal.

No	Meteorological Station	Hm	The thermal regime (°C)				The pluviometric regime (l/m^2)				
			W`18-`19	NW	Δ=W-N	CrH	SW	NW	Δ=S-N	Δ%	CrH
1	Dr. Tr. Severin	77	**2.2**	0.4	1.8	**W**	175.9	160.5	15.4	9.6	**LR**
2	Calafat	66	2.0	-0.1	**2.1**	**W**	102.1	123.9	-21.8	-17.6	**LD**
3	Bechet	65	1.0	-0.6	1.6	**W**	***49.7***	104.6	***-54.9***	***-52.5***	**ED**
4	Băileşti	56	0.9	-0.7	1.6	**W**	95.0	121.4	-26.4	-21.7	**D**
5	Caracal	112	0.9	-1.2	**2.1**	**W**	105.7	108.7	-3.0	-2.8	**N**
6	Craiova	190	0.6	-1.0	1.6	**W**	142.0	109.7	32.3	29.4	**VR**
7	Slatina	165	0.5	-0.8	1.3	**W**	119.6	117.2	2.4	2.0	**N**
8	Bâcleş	309	0.5	-1.4	1.9	**W**		149.3			
9	Tg. Logreşti	262	-0.6	-1.1	0.5	**N**	191.6	121.7	69.9	57.4	**ER**
10	Drăgăşani	280	1.2	-0.6	1.8	**W**	165.1	114.1	51.0	44.7	**ER**
11	Apa Neagră	250	-0.7	-1.0	***0.3***	**N**	**262.1**	219.6	42.5	19.4	**R**
12	Tg. Jiu	210	0.1	-1.0	1.1	**W**	230.9	169.9	61.0	35.9	**VR**
13	Polovragi	546	-0.1	-1.5	1.4	**W**	206.1	153.4	52.7	34.4	**VR**
14	Rm. Vâlcea	243	1.1	-0.6	1.7	**W**	196.9	120.1	**76.8**	**63.9**	**ER**
15	Voineasa	573	***-1.3***	-3.0	1.7	**W**		141.8			
16	Parâng	1585					209.0	160.0	49.0	30.6	**VR**
	Average for Oltenia	-	0.6	-0.95	1.55	**W**	158.9	137.2	21.7	15.8	**LR**
17	Ob. Lotrului	1348	-4.7	-5.5	0.8	**WS**	311.2				

(Source: processed data from the N.A.M. Archive)

The monthly minimum values for many weather stations were registered on the morning of January 5: Craiova (-11.7°C); Voineasa (-16.9°C); Parâng (-17.1°C) and Obârşia Lotrului (-24.0°C), which is the ***minimum thermal value of the winter 2018-2019***) (Table 4). This accelerated cooling of the weather brought an interval of 10 cold days, of which 4 nights were frost nights on average for the entire region. We will further analyse the ***synoptic situation from January 5, 06 UTC***. On January 5, 2019, at 06 UTC, at *ground level*, above Western Europe, the Azores Anticyclone extended northwards and connected, through a high-pressure belt across the Scandinavian Peninsula, to the East European Anticyclone that was further connected with the Asian Anticyclone (Fig. 5). A strong anticyclone centre with pressure above 1040 hPa was positioned above the English Channel. The East European Anticyclone was quite strongly developed, with atmospheric pressure values ≥1040 hPa, as well as the Asian Anticyclone. In the south of the Balkan Peninsula and west of Asia Minor, a weak Mediterranean Cyclone was placed, in occlusion, with pressure at the centre ≤1015 hPa. To the north, separated by an anticyclone belt, there is a quite large cyclone field, located southeast of the Scandinavian Peninsula, above the vast plain area of Eastern Europe. In the south-west of Romania, an anticyclone nucleus acted, with atmospheric pressure values ≥1025 hPa. In these conditions, above Romania, in the *lower troposphere*, the air circulation was from the eastern sector with a continental cold air mass mixed with arctic air (cPk + A). This distribution of the pressure field is a *true mechanism through which cold air penetrates* over Romania. In the *upper troposphere*, at the level of 500 hPa, it was an atmospheric blocking circulation (the shape of the letter "Ω" of the 552 damgp isohypse – Fig. 5). The atmospheric blocking was highly developed with the 576 damgp isohypse extending to the south of Great Britain. For Romania (and Oltenia), at this level, air circulation was northern, with Arctic Air (A) rapidly brought on the "shortest route" from the Arctic region. The advection of cold air over Europe was initiated on January 1 and, on January 3, it began to penetrate over the west of Romania. The maximum intensity of the cold air advection as well as its expansion over Europe was recorded on January 5 at 00 UTC (Fig. 6), when the -12.0°C isotherm was located in the west of Oltenia and, south of the Danube (above Bulgaria), values of -14°C were registered. Extremely cold air advection persisted over Europe (and Romania) until January 14, 2019 at 00 UTC. We remark that this type of atmospheric circulation caused the installation of sudden winter conditions on the night of November 18/19, 2018, thus ending the warm and dry autumn of 2018; they also caused the sharp cooling of the weather from the end of November (when there were registered the thermal minimum values of November) and from the beginning of December (when the minimum thermal values of December were registered). The Scandinavian Peninsula is thus a bridge between Europe and the Arctic, enabling cold air advections across Europe. We also note that, in the first two months of the 2018 summer, this type of atmospheric circulation determined the characteristic of rainy summer. In Oltenia, the *short episode of blizzard from February 2019* was caused by an atmospheric blocking of circulation, which produced a strong hot air advection in Western Europe that led to the registration of thermal records for February. Thus, on February 25, 2019, in the United Kingdom temperature reached 20.6°C at Trawsgoed, Wales (according to the British Meteorological Service) which had never happened before. "There has never been such a thing (...) in Wales, 20.6°C is really like in summer", (Etienne Kapikian, meteorologist, Météo-France).

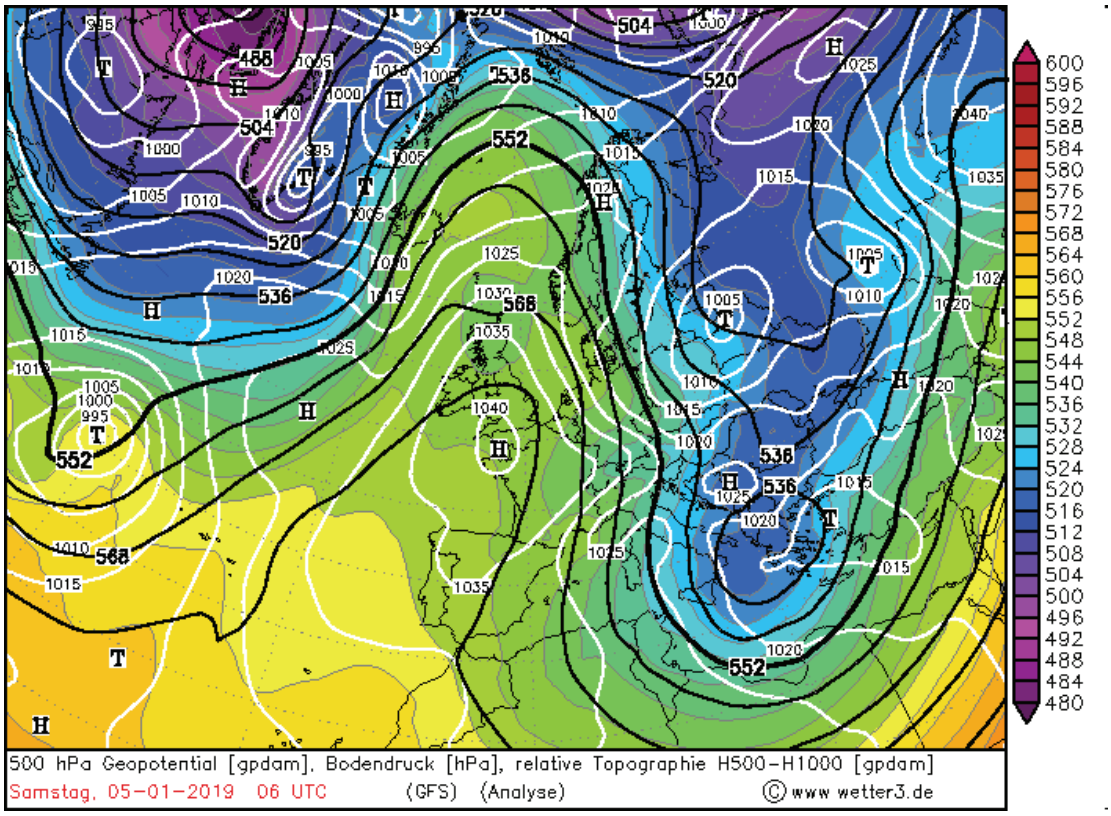

Figure 5. The synoptic situation at the ground level (atmospheric pressure field) overlapped with the altitude synoptic situation (geopotential field at 500 hPa – about 5000 m altitude) and the field of relative baric topography (TR500 / 1000) on January 5, 2019 at 06 UTC (www.wetterr3.de).

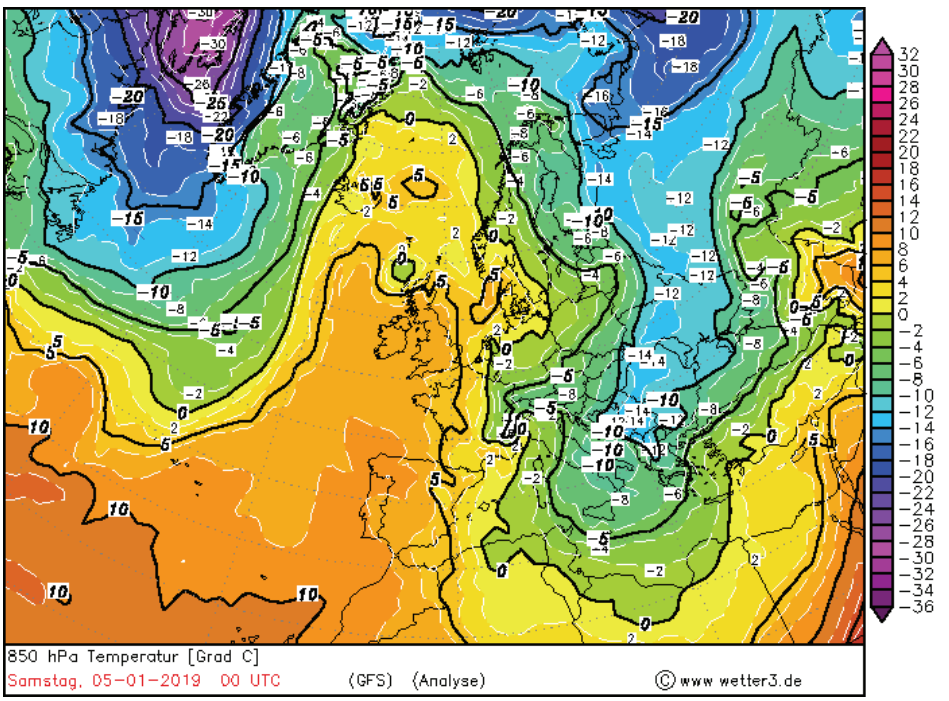

Figure 6. The thermal field at the level of 850 hPa geopotential field – about 1500 m altitude, on January 5, 2019, at 00 UTC (www.wetterr3.de).

Monthly records were also registered in other areas of Western Europe on February 23-25: 25.0°C at Ourense, Spain, 21.0°C at Pleyber-Christ, France, and 18.8°C in Uccle, Belgium. Temperatures were spring-like also in Scandinavia, with a record of 9.1°C for February, registered at Kvikkjokk, Sweden, near the Polar Circle on February 23, 2019 and 17.8°C at Linge, Norway. At the same time, the thermometer did not indicate more than 5.0°C in Lecce, Italy or 3.0°C in Thessaloniki, Greece, where it snowed in the interval February 23-24, as well as in northwestern

Turkey (AFP, Kapikian meteorologist, Météo-France) (https://www.realitatea.net/scenariu-terifiant-devenit-realitate-schimbari-climatice-incredibile_2182130.html).

The thermal classification of the winters in Oltenia in the period 1961-2019. The statistical analysis of the seasonal temperature registered during winter in the period 1961-2019 according to Hellmann criterion, calculated for the entire Oltenia region, shows that: ***the coldest winters*** (cold (C) and very cold (VC)) in the last 58 years were: ***1962-`63 (VC, average -4.48°C)***, ***1963-`64*** (C, average -2.98°C), ***1968-`69*** (C, average -2.96°C), ***1977-`78*** (C, average -2.20°C), ***1984-`85 (VC, average -4.57°C)***, ***1995-`96*** (C, average -2.35°C) and ***2002-`03*** (C average -2.93°C), namely 6 winters (10.3%).

The ***coldest winter*** was ***1984-`85 (VC, with an average of -4.57°C***), and the number of very cold winters was 2 (1962-`63 and 1984-`85), both recorded before 1990. ***The warmest winters*** in the last 58 years (warm (W) and very warm (VW)) were: 1965-`66 (W, average 1.19°C), 1970-`71 (W, average 0.68°C), 1974-`75 (W, average 0.98°C), 1976-`77 (W, average 0.76°C), ***1982-`83 (VW, average 2.05°C)***, 1987-`88 (W, average 1.98°C), 1988-`89 (W, average 1.31°C), 1989-`90 (W, average 0.6°C), 1993-`94 (W, average 1.43°C), 1994-`95 (W, average 0.88°C), 1997-`98) (W, average 1.35°C), ***2000-`01 (VW, average 1.79°C)***, 2001-`02 (W, average 0.51°C), ***2006-`07*** (***VW***, ***average 3.44°C***), 2008-`09 (W, average 0.89°C), 2012-`13 (W, average 0.35°C), 2013-`14 (W, average 0.69°C), 2014-`15 (W, average 1.21°C), ***2015-`16 (VW, average 2.88°C)***, 2017-`18 (W, average 1.48°C), 2018-`19 (W, average 0.55°C), namely 21 winters (36.2% of the total number of winters). ***The warmest winter***, ***which is the absolute climatic record of warm winters throughout the history of weather observations***, ***was 2006-2007 with the average for the entire region of 3.44°C*** (Table 7). *The number of very warm winters was 4*, namely double the number of very cold winters (of the symmetrical class of negative deviations). *The number of winter warmer than normal* (WS + W + VW) was 31, namely 53.5%, which shows that winters warmer than the normal prevail in Oltenia in the proportion > 50.0%. *The number of winters cooler than normal* (CO + CL + VC) was 9, namely only 15.5% of the total. *The average of winter temperature* between 1961 and 2019 is -0.32°C and its deviation from the normal is 0.63°C, indicating that on average, the winters of the last 58 years were warm (W).

Table 7. Thermal classification of winters in Oltenia between 1961 and 2019 (the last 58 years) (**AvgT** = winter average temperature calculated for the entire Oltenia region with altitudes below 600 m (°C), (the normal winter temperature average is -0.95°C in Oltenia) Type = thermal classification of winter according to Hellmann[8] criterion, Cold = number of winters colder than the normal and their percentage, Normals = number of winters thermally normal and their percentage, Warm = number of winters warmer than the normal and their percentage, VC = very cold, CL = cold, CO = cool, N = normal, WS = warmish, W = warm, VW = very warm, EW = excessively warm).

No	winter	AvgT	Type	No	winter	AvgT	Type	No	winter	AvgT	Type	No	winter	AvgT	Type
1	1961-`62	-0.98	**N**	17	1977-`78	-2.20	**CL**	33	1993-`94	1.43	**W**	49	2009-`10	-1.10	**N**
2	1962-`63	-4.48	**VC**	18	1978-`79	-0.81	**N**	34	1994-`95	0.88	**W**	50	2010-`11	-0.91	**N**
3	1963-`64	-2.98	**CL**	19	1979-`80	-0.57	**N**	35	1995-`96	-2.35	**CL**	51	2011-`12	-1.53	**CO**
4	1964-`65	-1.12	**N**	20	1980-`81	-0.37	**WS**	36	1996-`97	0.02	**WS**	52	2012-`13	0.35	**W**
5	1965-`66	1.19	**W**	21	1981-`82	-1.18	**N**	37	1997-`98	1.35	**W**	53	2013-`14	0.69	**W**
6	1966-`67	-0.97	**N**	22	1982-`83	2.05	**VW**	38	1998-`99	-1.18	**N**	54	2014-`15	1.21	**W**
7	1967-`68	-0.10	**WS**	23	1983-`84	-0.19	**WS**	39	1999-`00	-0.03	**WS**	55	2015-`16	2.88	**VW**
8	1968-`69	-2.96	**CL**	24	1984-`85	**-4.57**	**VC**	40	2000-`01	1.70	**VW**	56	2016-`17	-1.35	**N**
9	1969-`70	-0.64	**N**	25	1985-`86	-0.18	**WS**	41	2001-`02	0.51	**W**	57	2017-`18	1.48	**W**
10	1970-`71	0.68	**W**	26	1986-`87	-1.72	**CO**	42	2002-`03	-2.93	**CL**	58	2018-`19	0.55	**W**
11	1971-`72	-0.13	**WS**	27	1987-`88	1.28	**W**	43	2003-`04	-0.62	**N**		Mean	-0.32	**W**
12	1972-`73	-0.40	**WS**	28	1988-`89	1.31	**W**	44	2004-`05	-0.07	**WS**		Cold	9	15.5%
13	1973-`74	-0.24	**WS**	29	1989-`90	0.46	**W**	45	2005-`06	-1.29	**N**		Normal	18	31.0%
14	1974-`75	0.98	**W**	30	1990-`91	-0.94	**N**	46	2006-`07	**3.44**	**VW**		Warm	31	53.5%
15	1975-`76	-0.79	**N**	31	1991-`92	-0.62	**N**	47	2007-`08	-0.51	**N**				
16	1976-`77	0.76	**W**	32	1992-`93	-1.42	**N**	48	2008-`09	0.89	**W**				

(Source: processed data from the N.A.M. Archive)

The graph of winter temperature variation calculated for the entire Oltenia region in the interval 1961-2019 shows a significant increasing linear trend (Fig. 7).

[8] The comparison was made with the December multiannual average for the last century, average calculated for the whole region (1901-1990). ***The comparison with the statistical median is irrelevant***, as the median has no connection to the dataset other than that the value is positioned at the middle of the dataset arranged ascending order.

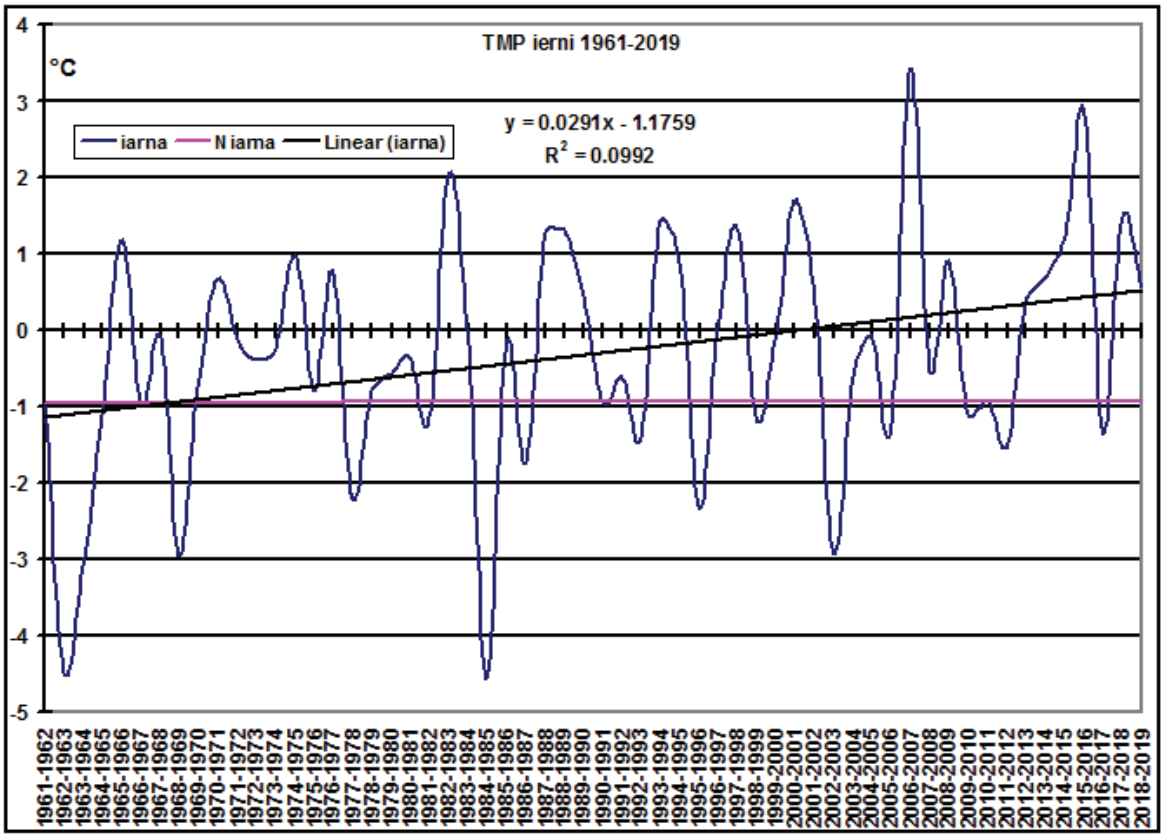

Figure 7. Variation of the average winter temperature calculated for the entire region Oltenia in the interval 1961-2019.

CONCLUSIONS

Although the winter of 2018-2019 began a little earlier than usual from a meteorological point of view (on the night of November 18-19) with intense cooling, snowfalls and snow layer formation. December was thermally normal and the weather gradually warmed up in January, especially in the second half, while in February, the ***warming*** increased. Thus, in February, only one winter day was registered for the entire region on the 23rd, when the average of the maximum temperatures was -0.8°C. This continuous warming process of the weather triggered the early spring arrival[9]. Thus, the winter 2018-2019 was warm (W) with a general average of 0.55°C (for the area with altitudes <600 m, without Oltenia mountain area). From the ***pluviometric*** point of view, the winter was a little rainy (LR) with intermittent snow layer in Oltenia Plain and persistent in Gorj County, northeast of Mehedinţi County and northwest of Vâlcea County. The statistical analysis of the *winter temperature* in the period 1961-2019 shows that warm winters predominate – 53.5%, normal winters represent 31.0% and cold winters only 15.5%. The graph of the variation of ***winter average temperature*** has a markedly increasing linear trend. For the 1961-2019 interval, the average seasonal temperature was -0.32°C, with a deviation from the normal of 0.63°C, which confirms that the winters of this interval were warm (W). The *frost units* for the whole winter season were 36.5 in Drobeta Turnu Severin and 168.0 in Voineasa with the average for the whole region of 101.7. The *heat units* were greater than the frost units and ranged between 44.3 in Voineasa and 233.7 in Calafat with the average for the entire region of 145.6, which signifies a mild winter from an agrometeorological point of view. Climatic warming continued although the El Niño climatic process was absent and solar activity was minimal. Winter weather phenomena suddenly interrupted the dry and warm autumn, and the *spatial-temporal distribution* of rainfalls was particularly variable. At the end of the winter, on February 26, 2019, in the crop of autumn wheat, the supply of water accessible to plants on the soil depth of 0-100 cm was within satisfactory limits, close to optimal and optimal, in most of the region (according to N.A.M.). As a result of the warmer weather than normally, vegetable harvesting in greenhouses started two weeks earlier (on February 9, 2019) than in the previous winter (2017-2018).

[9] ***Spring arrival*** is the climatic process of increasing air temperature that usually occurs starting with February 1, as a result of the increase in daylight, which has important consequences for crops and biotopes, which gradually restart their activity.

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.III.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.

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 şi schimbări climatice*. Edit. Universitaria. Craiova. 306 pp.

***. https://www.descopera.ro/natura/17866631-2018-al-patrulea-cel-mai-cald-an-inregistrat (accessed February 2019).

***. http://www.meteoromania.ro/ (accessed February 2019).

***. https://www.digi24.ro/meteo/meteorologi-2019-ar-putea-fi-unul-dintre-cei-mai-calzi-ani-din-istorie-1052159 (accessed February 2019).

***. https://www.groundzeromedia.org/2-14-19-apocalypse-theorem/ (accessed February 2019).

***. https://www.realitatea.net/scenariu-terifiant-devenit-realitate-schimbari-climatice-incredibile_2182130.html (accessed February 2019).

***. htps://www.profit.ro/stiri/life/luna-ianuarie-2019-cea-mai-calda-din-istoria-australiei-18835783 (accessed February 2019).

***. www.wetterr3.de (accessed February 2019).

***. http://en.wikipedia.org/wiki/Biocenoz%C4%83 (accessed February 2019).

Marinică Andreea Floriana
Bachelor of Sciences, Klimacampus, Hamburg, gGmbH., Germany.
E-mail: marinica.andreea@gmail.com

Marinică Ion
Associate Professor, University of Craiova, Faculty of Sciences, Bibescu Street no. 84, Craiova, Romania.
E-mail: ionmarinica@yahoo.com

Chimişliu Cornelia
The Oltenia Museum Craiova, Str. Popa Şapcă, No. 8, Craiova, Romania.
E-mail: chimisliu_cornelia@yahoo.com

Received: April 2, 2019
Accepted: July 08, 2019