

THE WARM WINTER OF 2020-2021 IN SOUTH-WEST ROMANIA IN THE CONTEXT OF CLIMATE CHANGE

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Abstract. After the warm and dry autumn of 2020, in which the secondary maximum of precipitations was registered in October, the winter of 2020-2021 was as a whole very warm (FC) with a general seasonal average of 2.55°C and a deviation from the normal of 3.5°C. December 2020 was warm and exceptionally rainy (EP). January 2021 was warm (C), and from a pluviometric point of view it was excessively rainy (EP). February was warm (C) as a whole and excessively dry (ES), but the water supply in the soil remained almost optimal due to the autumn rainfall and especially the rainfall from December and January. The climatic variability of this winter was particularly high, and global warming continued. Solar activity was close to a minimum and the new solar cycle (25th) began in January 2020. The La Niña climatic process from 2020-2021 peaked in October-December 2020 as an event of moderate intensity. The latest forecasts from the WMO World Center for Long-Term Forecasts indicate a moderate probability (65%) that La Niña climatic process will continue in February-April. At the level of Oltenia, the winter of 2020-2021 was the fourth warmest winter in the history of climatic records so far with a seasonal average of 2.55°C, the first being 2006-2007 (with an average of 3.44°C), the second 2019-2020 (with an average of 2.89°C), and the third 2015-2016 (with an average of 2.88°C). The paper is part of an extensive series of studies on climate variability in southwestern Romania and climate change at the regional level and is useful to all those interested in climate issues and its evolution in this part of Romania.

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

Rezumat. Iarna caldă 2020-2021 în sud-vestul României în contextul schimbărilor climatice. După toamna caldă și secetoasă 2020 în care maximul secundar de precipitații s-a înregistrat în luna octombrie, iarna 2020-2021 a fost în ansamblul său foarte caldă (FC) cu media anotimpuală generală de 2,55°C și abaterea față de normală de 3,5°C. Luna decembrie 2020 a fost caldă și excepțional de ploioasă (EP). Luna ianuarie 2021 a fost caldă (C), iar din punct de vedere pluviometric a fost excesiv de ploioasă (EP). Luna februarie a fost caldă (C) în ansamblul său și excesiv de secetoasă (ES), dar rezerva de apă din sol s-a menținut aproape de optim datorită precipitațiilor din toamnă și mai ales din decembrie și ianuarie. Variabilitatea climatică a acestei ierni a fost deosebit de mare, iar încălzirea climatică a continuat. Activitatea solară a fost apropiată de minim și noul ciclu solar (al 25-lea) a început în ianuarie 2020. Procesul climatic La Niña din 2020-2021 a atins punctul culminant în octombrie-decembrie ca un eveniment de intensitate moderată. Cele mai recente prognoze de la Centrele mondiale de prognoză ale OMM pentru prognoze pe termen lung indicau o probabilitate moderată (65%) ca procesul climatic La Niña să continue în februarie-aprilie. La nivelul Olteniei iarna 2020-2021 a fost a patra cea mai caldă iarnă din istoria înregistrărilor climatice până în prezent cu media anotimpuală de 2,55°C, prima fiind 2006-2007 (cu media de 3,44°C), a doua 2019-2020 (cu media de 2,89°C), iar a treia 2015-2016 (cu media de 2,88°C). Lucrarea face parte dintr-o serie extinsă de studii privind variabilitatea climatică în sud-vestul României și schimbările climatice la nivel regional și este utilă tuturor celor interesați de problemele climatului și evoluția lui în această parte a României.

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

INTRODUCTION

Globally, the year 2020 ended the warmest decade (2011-2020) since the beginning of Earth meteorological measurements (WMO). The year 2020 may be one of the warmest three years on record, competing with 2016, which was the warmest year on record. The high temperatures of 2020 were recorded despite a cool "La Niña", which reached its maximum intensity in December 2020 and January 2021 (WMO, quoted by Mediafax). "The warmest years, with record temperatures, usually coincided with a strong El Niño process, as happened in 2016. Although La Niña has a cooling effect on global temperatures, it was not enough to mitigate the heat of the atmosphere in 2020. Despite the La Niña process, the year 2020 had an almost record temperature, comparable to the previous record of 2016" (<https://public.wmo.int/en/our-mandate/climate/el-ni%C3%B1o-la-ni%C3%B1a-update>) (WMO Secretary General, Prof. Taalas). According to the WMO Provisional Climatic Report issued on 2 December, all five data sets for the first ten months of 2020 (by the end of October) ranked 2020 as the second warmest year so far, after 2016 and before 2019. The warm weather continued in November 2020, based on the monthly reports of the institutions involved, which classifies November as the warmest or the second warmest recorded. The global average temperature in 2020 was about 1.2°C above the pre-industrial level (1850-1900) and there is at least a one in five chance of exceeding 1.5°C by 2024, according to WMO (WMO documents, <https://www.hotnews.ro/stiri-esential-24508123-anul-2020-incheie-cel-mai-cald-deceniu-inceperea-masuratorilor-potrivit-organizatiei-meteorologie-mondiale.htm>).

For Romania, 2019 was the warmest year in the history of meteorological measurements in Romania (1900-2019), and its general average surpassed the previous record of 2015 (according to ANM, https://www.realitatea.net/news/weather/director-anm-confirms-the-year-2019-the-warmest-year-in-romania-from-the-history-of-measurements_5e08fe71218e354ad33ef24e). In 2019, the deviations of the positive monthly averages from the normal

ones were significant in nine months out of the 12 of the year. November 2019 was the warmest in the last 140 years with a deviation from the normal of 4.9°C. In terms of the monthly average temperature in Romania, June was the warmest in the history of meteorological measurements.

At regional level, for *Oltenia*, in terms of the annual average temperature, the year 2020 was the third warmest in the last 7 years with the general average for the entire region of 12.18°C (except the mountain area). The annual thermal maximum in 2020 was 37.5°C registered at Bechet on 31.VIII.2020 (thermal maximum for the whole of Romania was 39.3°C registered on 1.IX.2020 at Zimnicea). The largest deviations of the monthly average temperatures in 2020 were registered in February 2020 (5.4°C), January 2020 (3.2°C), December 2020 (3.02°C) and 2.97°C in February 2021, confirming the more significant warming of the weather in the winter season, which is in line with the national and global issues. At the same time, it is shown that the warmer-than-normal weather has extended during the winter of 2020-2021, and in January 2021 the deviation of the monthly average temperature from normal was 4.06°C. Between 23.II - 7.III.2021, a strong heat wave affected Europe and especially the countries around the Mediterranean Sea, and the peak of this heat wave was registered on 27.II, when maximum temperature values $\geq 20.0^\circ\text{C}$ were registered in many Romanian localities, with a thermal maximum of 23.1°C at Băile Herculane on 26.II.2021.

The paper is part of a series of extensive studies on climate variability in the southwest of the country and the effects of global warming, being useful to all those interested in climate change in this part of Romania (BOGDAN et al. (2007, 2008); BOGDAN & MARINICĂ (2009); BOGDAN et al. (2010, 2014); MARINICĂ & CHIMIȘLIU (2008); MARINICĂ et al. (2010, 2011, 2012, 2013); MARINICĂ I. & MARINICĂ ANDREEA FLORIANA (2016). We will further analyse the multiple aspects of climate variability in Oltenia characteristic of the winter 2020-2021, at regional level in Oltenia and the consequences on agricultural crops, biotopes, economy and the environment in general.

MATERIAL AND METHOD

To carry out the work we used the results of daily processing with special software from the weather forecasting process, the ANM¹ data archive, the maps currently made in the operational activity, those on the Internet provided by the international analysis and forecasting centers and those from ANM Bucharest. We used the facilities provided by Microsoft Office for drawing up tables and graphs.

The paper analyses the climatic variability from the warm winter of 2020-2021 in southwestern Romania, based on the thermal and pluviometric regime of December 2020, January and February 2021 and the overall thermal and pluviometric regime of the winter 2020-2021. The effects on the environment and biotopes were also analysed.

RESULTS

1a. The thermal regime of December 2020.

The monthly averages of the air temperature ranged between 1.1°C at Voineasa and 4.3°C at Dr. Tr. Severin, and their deviations from the norms calculated for the reference period of 1901-1990 were between 2.5°C at Calafat and Polovragi and 3.6°C at Tg. Jiu (Table 1). According to the Hellmann criterion, December 2020 was warm (C) throughout the Oltenia region.

The monthly average air temperature calculated for the entire Oltenia region was 3.2°C, and its deviation from normal was 3.02°C, which confirms that December 2020 was warm (C) for the entire Oltenia region. Only in the first three days of the month, the overall average air temperature for the entire region was negative. The highest monthly average for the entire region was 6.9°C recorded on 30.XII.2020. *The monthly minimum air temperatures* were recorded on 1 and 2.XII.2020 and were between -10.7°C at Apa Neagră (1.XII.2020) and -2.3°C at Bechet (2.XII.2020), and their average for the entire region was -6.0°C. *The monthly maximum air temperature* was recorded on 24, 28, 29 and 30.XII.2020 and were between 9.8°C in Voineasa (24.XII.2020) and 17.8°C in Bechet (24.XII.2020), and their average for the whole region was 13.3°C. All averages of the daily maximums calculated for the whole region were positive and therefore no winter day was recorded for the whole of Oltenia as a whole. There were two particularly warm periods in which the daily maximums reached and exceeded 10.0°C: 23-25.XII and 29-31.XII, totaling 6 days, and the latter was extended until the 7.I.2021. In terms of the average air temperature calculated for the entire Oltenia region, the warmest day was 30.XII with an average of 6.9°C for the entire region, and the coldest on 2.XII.2020 with an average of -2.39°C. *At ground level, the monthly minimum temperatures* were recorded in the data of 1, 2, 3, 5, 8, 9 and 10.XII and were between -9.2°C at Polovragi (1.XII.2020) and -0.8°C in Drăgășani (10.XII.2020), and their average for the entire region was -4.5°C. *The monthly maximum temperatures* at the ground surface were recorded on 23, 24, 28, 29 and 30.XII.2020 and ranged from 12.5°C in Caracal (29.XII.2020) to 17.2°C at Polovragi (23.XII.2020), and their average for the entire region was 15.1°C (Fig. 1).

¹ ANM= Administrația Națională de Meteorologie (National Meteorological Administration).

Table 1. The air temperature regime in Oltenia and the minimum and maximum surface temperature values in December 2020 (N XII = December norms calculated for the period 1901-1990, M XII = monthly averages of December 2020; Δ = M-N = deviation temperature, CH = Hellmann criterion).

No crt	Meteorological Station	Hm	NXII	MXII	Δ=M-N	CH	Tmax air		Tmin air		Tmax ground		Tmin ground	
							(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
1	Dr. Tr .Severin	77	1,4	4,3	2,9	C	16,3	24	-3,6	1	15,8	24	-7,2	1
2	Calafat	66	1	3,5	2,5	C	17,3	24	-7,8	1	13,9	24	-1,8	9
3	Bechet	65	0,4	3,7	3,3	C	17,8	24	-2,3	2	14,9	24	-1,1	8
4	Bailesti	56	0,4	3,5	3,1	C	16,4	24	-5,1	1	19,1	24	-5,8	1
5	Caracal	112	-0,1	3,3	3,4	C	12,7	29	-2,9	2	12,5	29	-1,5	5
6	Craiova	190	0,1	3,3	3,2	C	13,2	24	-4	2	13,6	24	-4,6	3
7	Slatina	165	0,3	3,4	3,1	C	11,8	30	-3,4	2	12,8	30	-3,4	2
8	Bacles	309	-0,4	3	3,4	C	13,1	24	-4,2	1	-	-	-	-
9	Tg. Logresti	262	0,1	3,4	3,3	C	12,9	30	-6	2	16,8	30	-4,9	3
10	Dragasani	280	0,6	3,2	2,6	C	11,8	30	-4,6	1	15,7	30	-0,8	10
11	Apa Neagra	250	0,1	2,8	2,7	C	12,9	30	-10,7	1	14,5	30	-5	2
12	Tg. Jiu	210	0,1	3,7	3,6	C	13,8	30	-5,7	1	14	29	-4,8	1
13	Polovragi	546	0,1	2,6	2,5	C	12,6	29	-8,1	1	17,2	23	-9,2	1
14	Rm. Valcea	243	0,5	3,9	3,4	C	12,9	28	-6,5	1	15,1	28	-8,9	1
15	Voineasa	587	-1,9	1,1	3	C	9,8	24	-10,5	2	-	-	-	-
16	Parang	1585	-3,7	-	-	-	7,4	15	-10,1	1	-	-	-	-
17	Media Oltenia		0,18	3,2	3,02	C	13,3		-6,0		15,1		-4,5	
18	Ob. Lotrului	1404	-4,9	-1,8	3,1	C	6,6	30	-15,8	1	-	-	-	-

(Data source processed from the ANM archive)

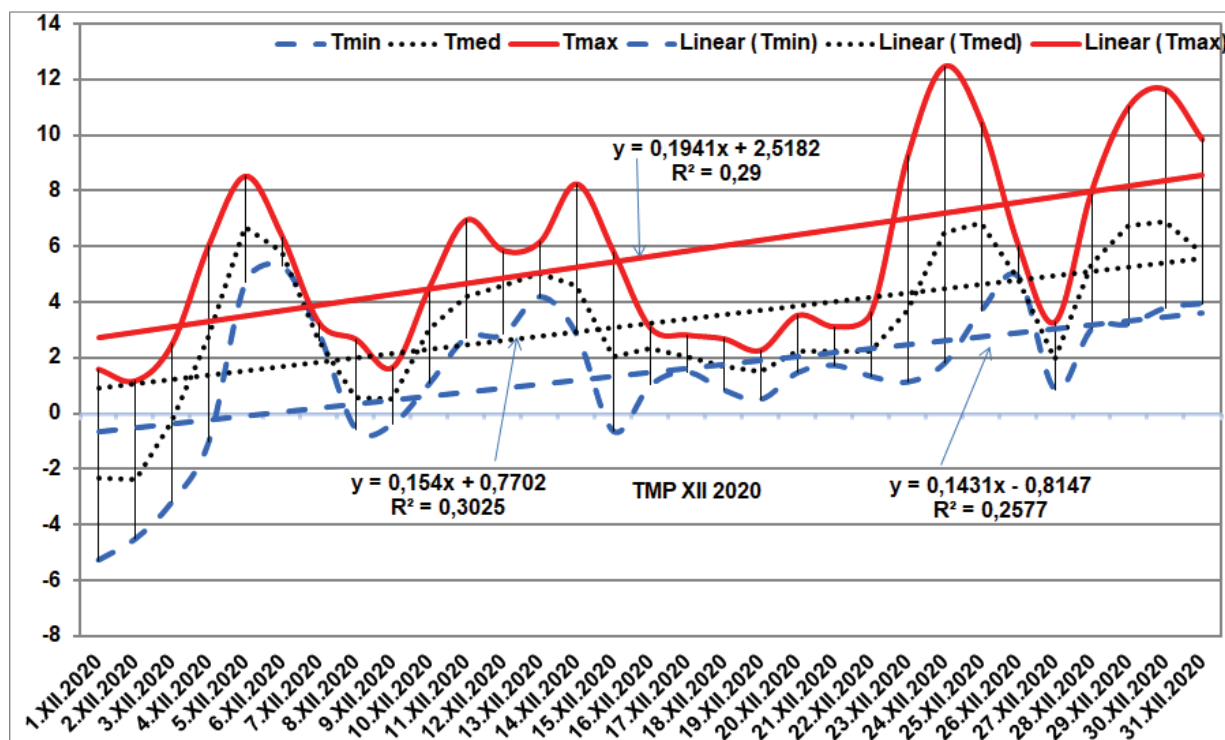


Figure 1. Variation of the parameters that characterize the air temperature (average daily minimums, daily average and average daily maximums, calculated for the entire region) in December 2020 (Data source processed from the ANM archive).

The vernalization² process took place during the cold period of the month (1-3.XII). The cold units³ were insignificant and ranged between 1.0 at Dr. Tr. Severin and 26.8 at Voineasa (the one in Voineasa is the only value >13), and their average for the

² Vernalization is the acquisition or acceleration of flowering capacity under the influence of exposure to low temperatures.

³ The degree of harshness of winter in agrometeorology (winter type) is classified according to the sum of agrometeorological frost units (Σ of the differences between the values of minimum daily temperatures < -15°C and the critical agroclimatic threshold of -15.0°C, in the interval XII-II). Therefore an agrometeorological frost unit is the difference of 1°C which is obtained between the critical threshold of -15.0°C and a minimum thermal in the air ≤ -15°C (for example for T min = -16.0°C then the difference -15.0°C - (-16.0°C) = 1, ie a unit of frost, (SANDU, MATEESCU, VĂTĂMANU, 2010); The units of cold for the entire cold season are calculated as med average daily temperatures ≤ 0°C, during November- March: A cold day is the day when the average temperature is ≤ 0°C; The active temperatures are ≥ 0°C and the minimum biological temperature is 0°C. It is called winter day, the day when the maximum air temperature is < 0°C Heat units (average daily temperatures ≥ 0°C). For diagnoses and weather forecasts intended for the public through frost, a temperature is defined as ≤ -10.0°C. living organisms) differ from the agrometeorological frost (temperatures ≤ -15°C), the plants being better adapted to the climatic conditions (due to their cellular structure and specific biotic processes).

entire region was 6.3. *The heat units* were between 60.8 at Voineasa and 133.3 at Dr. Tr. Severin with the general average for the entire region of 106.5, which means a warm winter month. *The agrometeorological frost* was not recorded in any day. These thermal characteristics had a special influence on the vegetal carpet and the biotopes that in December slowly continued their vegetative activity and biotic processes in biocenoses⁴, the value of 0.0°C being the temperature of the biological minimum. The statistical analysis of the evolution of the average air temperature in December in the last 60 years (1961-2020) leads to the conclusion that **December 2020 was the second warmest month in descending order of the average monthly temperature** for the entire region, after December 2015 with average of 5.19°C, and the third was December 1979 with an average of 3.21°C. *The graphs of the parameters' variation* that characterize the air temperature (the average of the daily minimums, the daily average and the average of the daily maximums all calculated for the whole region) in December 2020, had linear tendencies, significantly increasing (Figure 1). Due to the increase of the average monthly temperature, the frequency, duration and intensity of the cold waves decreased considerably in December, and the translation of the warm season to the cold one became stronger. Climate warming is thus demonstrated at the regional level, and the continuation of this climate process in 2020 (with an average of December of 3.23°C), was achieved in the conditions of solar activity close to the minimum and in the presence of the La Niña climate process.

1.b. Pluviometric regime of December 2020

The monthly precipitation amounts were between 45.8 l/m² at Bechet in the south of Oltenia and 158.5 l/m² at Apa Neagră in the area of the sub-Carpathian depressions. *The percentage deviations* of these quantities from the norms calculated for the reference period 1901-1990 were between 26.1% in Voineasa and 178.7% in Drăgășani (Table 2).

According to the Hellmann criterion, December 2020 was excessively rainy (EP) in most of Oltenia (Table 2). *The average monthly rainfall* calculated for the entire region was 85.3 l/m², and its percentage deviation from normal was 67.2%, which according to the Hellmann criterion confirms that "on average" December 2020 it was excessively rainy for the whole Oltenia region. The snow layer was transient and insignificant and was recorded between 8-10.XII.2020. At the end of December in the autumn wheat crop, the water content on the soil depth 0-100 cm, was located in limits close to optimal and optimal in most of Oltenia. *The soil moisture reserve* had values close to optimal and optimal, in most of Oltenia. Due to the warm weather and the water reserve in the soil, in December the agricultural crops continued their vegetation phases and their condition was good and very good in many agricultural areas in Oltenia. From a phenological point of view, barley and winter wheat sown in the optimal season were in the leafing and twinning phases (10-100%), and in late crops with a good and average uniformity and vigor of the plants, respectively medium and weak. (<http://www.meteoromania.ro/>).

2a. Thermal regime of January 2021.

The monthly averages of the air temperature were between -1.2°C at Voineasa and 3.2°C at Craiova. Only one meteorological station - Voineasa - located at the border of the mountain area, had a negative monthly average temperature (Table 3).

The deviations of the monthly temperature averages from normal were all positive and ranged between 3.2°C at Apa Neagră and 5.8°C at Craiova. According to the Hellmann criterion, **January 2021 was warm (C)** in most of the region, except for the Craiova area where it was very warm (FC) (Table 3). In terms of the average temperature in the whole region, the warmest day was 4.I.2021 with an average of 6.8°C. *The monthly minimum air temperatures* were recorded, most of them, on 18.I.2021 and ranged between -14.7°C at Voineasa (18.I.2021) and -6.8°C at Dr. Tr. Severin (18.I.2021), and their average for the entire region was -11.2°C. *The monthly maximum air temperatures* were recorded on the dates of 1, 23, 24 and 30.I (most on 30.I.2021) and were between 8.5°C at Voineasa (30.I.2021) and 15.4°C at Bechet (24.I.2021), and their average for the entire region was 12.1°C. The daily averages of the diurnal maxima calculated for the whole region were all positive except for the data of 16, 17 and 18.I (with averages of -0.2°C, -0.8°C and -0.8°C) which shows there were only three days in the whole region. The daily average air temperature maxima calculated for the whole region were $\geq 5.0^\circ\text{C}$ in 17 days and $\geq 10.0^\circ\text{C}$ in 4 days. *The highest average of daily maxima* calculated for the entire region was 12.4°C, recorded on 30.I.2021.

At the surface of the soil, the monthly minimum temperatures were recorded on 17, 18 and 19.I.2021 and ranged between -18.2°C at Polovragi (18.I.2021) and -7.2°C at Bechet (18.I.2021). *The average of monthly minimum temperatures* recorded at the soil surface for the entire region was -12.1°C. On seven days, the average of the minimums for the whole of Oltenia was positive, which shows that the soil was thawed day and night, and on most days there was an alternation of the phenomenon of frost / thawing at the soil surface. *The monthly maxima of the soil surface temperature* were recorded on 1, 2, 5, 7, 24 and 30.I.2021 and ranged between 12.9°C at Bechet (24.I.2021) and 18.8°C at Dr. Tr. Severin (30.I.2021), and their average for the entire region was 14.7°C (Table 3). *The cold units* ranged from 8 in Dr. Tr. Severin to 56.5 at Voineasa with an average of 25.3 for the entire region.

⁴ The term **biocenosis** (from the Greek koinosis - to divide) is a supra-individual level of organization of living matter and describes all living organisms, plants (*phytocenosis*) and animals (*zoocenosis*), which interact with each other and coexist in a particular environment or sector of biosphere (biotope), forming with it a unitary whole and which is in a dynamic equilibrium dependent on that environment. It is characterized by a certain structure and functioning given by the model of the circulation of matter, energy and information. The term biocenosis was proposed by Karl Möbius in 1877 (<http://ro.wikipedia.org/wiki/Biocenoz%C4%83>).

Table 2. Precipitation amounts recorded in winter 2020-2021 (Σ), compared to normal values⁵ (N); $\Delta\%$ = percentage deviation from normal, CH = Hellmann's criterion.

No. crt	Meteorological Statio	Hm	December 2020				January 2021				February 2021			
			Σ II	N	$\Delta\%$	CH	Σ I	N	$\Delta\%$	CH	Σ II	N	$\Delta\%$	CH
1	Dr. Tr. Severin	77	80,0	61,2	30,7	FP	120,5	51,4	134,4	EP	15,0	47,9	-68,7	ES
2	Calafat	66	79,5	45,5	74,7	EP	119,1	40,4	194,8	EP	7,9	38,0	-79,2	ES
3	Bechet	65	45,8	36,3	26,2	P	75,1	33,5	124,2	EP	4,4	34,8	-87,4	ES
4	Băilești	56	72,2	46,8	54,3	EP	110,3	38,5	186,5	EP	9,0	36,1	-75,1	ES
5	Caracal	112	65,2	39,5	65,1	EP	82,8	34,7	138,6	EP	7,2	34,5	-79,1	ES
6	Craiova	190	86,1	41,8	106,0	EP	83,0	37,5	121,3	EP	10,9	30,4	-64,1	ES
7	Slatina	165	70,8	42,8	65,4	EP	75,2	36,0	108,9	EP	11,4	38,4	-70,3	ES
8	Băcleș	309	35,6	54,7	-34,9	FS	59,1	50,5	17,0		8,6	44,1	-80,5	ES
9	Tg. Logrești	262	90,1	44,8	101,1	EP	104,7	35,9	191,6	EP	15,7	41,0	-61,7	ES
10	Drăgășani	280	124,3	44,6	178,7	EP	94,2	34,1	176,2	EP	7,5	35,4	-78,8	ES
11	Apa Neagră	250	158,5	82,3	92,6	EP	227,0	70,9	220,2	EP	38,5	66,4	-42,0	FS
12	Tg. Jiu	210	90,6	64,0	41,6	FP	136,5	53,9	153,2	EP	27,0	52,0	-48,1	FS
13	Polovragi	546	108,3	56,1	93,0	EP	143,0	48,9	192,4	EP	35,6	48,4	-26,4	FS
14	Rm. Vâlcea	243	111,2	46,2	140,7	EP	88,6	35,5	149,6	EP	18,5	38,4	-51,8	ES
15	Voineasa	587	69,5	55,1	26,1	P	79,3	42,7	85,7	EP	11,7	44,0	-73,4	ES
16	Parâng	1585	77,4	54,6	41,8	FP	127,5	57,7	121,0	EP	63,1	47,7	32,3	FP
	Media Oltenia	-	85,3	51,0	67,2	EP	107,9	43,9	145,8	EP	18,25	42,3	-56,9	ES
17	Ob. Lotrului	1404	118,6	-	-	-	154,3	-	-	-	40,5	-	-	-

(Data source processed from the ANM archive)

Table 3. The air temperature regime in Oltenia and the minimum and maximum surface temperature values in January 2021 (N I = January norms calculated for the period 1901-1990, M I = monthly averages of January 2021; $\Delta = M - N =$ temperature deviation, CH = Hellmann criterion).

No. Crt.	Meteorological Station	Hm	NI	MI	$\Delta=M-N$	CH	Tmax air		Tmin air		Tmax ground		Tmin ground	
							°C	Data	°C	Data	°C	Data	°C	Data
1	Dr. Tr. Severin	77	-1,1	2,9	4,0	C	13,7	30	-6,8	18	18,8	30	-11,4	17
2	Calafat	66	-1,8	2,1	3,9	C	13,7	1	-7,0	18	12,0	5	-10,0	18
3	Bechet	65	-2,2	1,9	4,1	C	15,4	24	-8,7	19	12,9	24	-7,2	18
4	Băilești	56	-2,3	1,9	4,2	C	11,9	30	-9,8	18	16,5	1	-15,2	18
5	Caracal	112	-2,9	1,6	4,5	C	12,5	30	-12,6	19	13,6	24	-11,8	19
6	Craiova	190	-2,6	3,2	5,8	FC	12,6	30	-10,6	18	14,6	24	-14,2	18
7	Slatina	165	-2,4	1,6	4,0	C	13,1	30	-12,1	19	13,4	7	-14,9	19
8	Băcleș	309	-3,0	1,1	4,1	C	11,6	30	-11,1	18				
9	Tg. Logrești	262	-2,7	0,8	3,5	C	12,2	23	-12,8	18	15,4	7	-12,4	18
10	Dragasani	280	-2,2	1,8	4,0	C	13,7	30	-9,8	18	15,6	2	-12,0	17
11	Apa Neagră	250	-2,6	0,6	3,2	C	13,0	30	-12,0	18	13,1	30	-8,9	18
12	Tg. Jiu	210	-2,6	1,5	4,1	C	13,0	30	-10,6	18	13,9	5	-10,0	18
13	Polovragi	546	-3,2	0,5	3,7	C	11,9	30	-12,6	18	16,0	24	-18,2	18
14	Rm. Vâlcea	243	-2,2	1,7	3,9	C	13,0	30	-9,4	18	15,5	24	-11,6	19
15	Voineasa	587	-4,7	-1,2	3,5	C	8,5	30	-14,7	18				
16	Parâng	1585					3,0	23	-17,8	18				
	Media Oltenia	-	-2,6	1,5	4,1	C	12,1		-11,2		14,7		-12,1	
17	Ob. Lotrului	1404	-6,2	-5,0	1,2	CL	4,4	24	-22,8	18				

(Data source processed from the ANM archive)

The heat units were between 13.0 at Voineasa and 121.4 at Craiova, with an average for the entire region of 70.1, thus exceeding 2.8 times the cold ones, which shows that January was a building year as a whole.

The agro-meteorological frost was registered isolated and transient on small areas (Băilești and Polovragi where the soil surface minimums dropped below -15.0°C). The graphs of the parameters' variation that characterize the air temperature (the average of the daily minimums, the daily average and the average of the daily maximums all these calculated for the whole region) in January 2021 had significantly increasing linear tendencies (Fig. 2).

At the surface of the soil, the monthly minimum temperatures were recorded on 17, 18 and 19.I.2021 and ranged between -18.2°C at Polovragi (18.I.2021) and -7.2°C at Bechet (18.I.2021). The average of monthly minimum temperatures recorded at the soil surface for the entire region was -12.1°C . On seven days, the average of the minimums for the whole of Oltenia was positive, which shows that the soil was thawed day and night, and on most days there was an alternation of the phenomenon of frost / thawing at the soil surface. The monthly maxima of the soil surface temperature were recorded in the data of 1, 2, 5, 7, 24 and 30.I.2021 and ranged between 12.9°C at Bechet (24.I.2021) and 18.8°C at Dr. Tr. Severin (30.I.2021), and their average for the entire region was 14.7°C (Table 3). The cold units were between 8 at Dr. Tr. Severin and 56.5 at Voineasa with an average for the entire region of 25.3. The heat units were between 13.0 at Voineasa and 121.4 at Craiova, with an average for the entire region of 70.1, thus

⁵ Voineasa and Băcleș meteorological stations because in the cold season, they have incomplete rainfall data, they cannot be taken into account.

exceeding 2.8 times the cold ones, which shows that January was a building year as a whole. The agro-meteorological frost was registered isolated and transient on small areas (Băilești and Polovragi where the soil surface minimums dropped below -15.0°C). *The graphs of the parameters' variation* that characterize the air temperature (the average of the daily minimums, the daily average and the average of the daily maximums all these calculated for the whole region) in January 2021, had significantly increasing linear tendencies (Fig. 2).

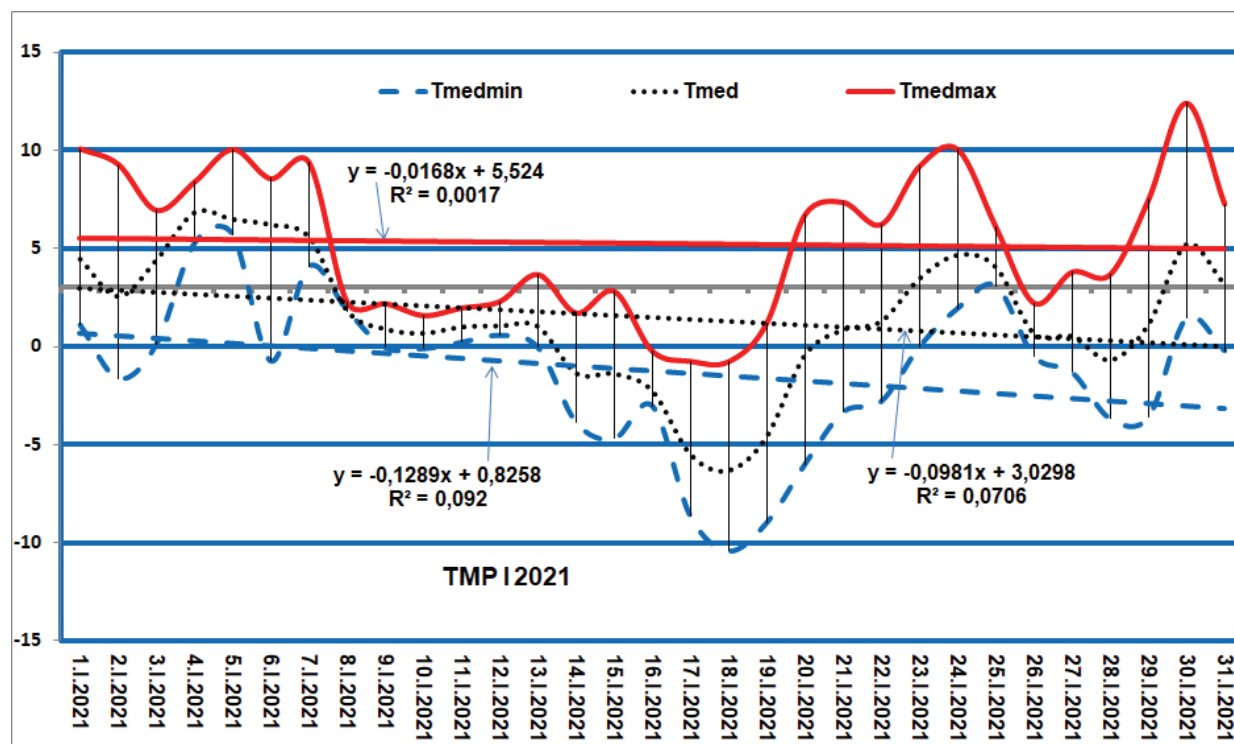


Figure 2. The variation of the parameters that characterize the air temperature (average daily minimums, daily average and average daily maximums, calculated for the entire region) in January 2021 (Data source processed from the ANM archive).

2.b. Pluviometric regime of January 2021

The monthly precipitation amounts were between 73.1 l/m^2 at Bechet and 227.0 l/m^2 at Apa Neagră, and their percentage deviations from the normal calculated for the reference period 1901-1990 were between 85.7% at Voineasa and 220, 2% at Apa Neagră. According to the Hellmann criterion, January 2021 was excessively rainy (EP) at all weather stations (Table 2). *The average monthly rainfall* calculated for the entire region was 107.9 l/m^2 , and its percentage deviation from normal was 145.8%, which confirms that January 2021 was on average excessively rainy (EP) for the whole Oltenia region. January 2021 was the richest month of rainfall in the entire cold season 2020-2021. As a result of the secondary rainfall maximum achieved in October and December 2020 as well as the excess quantities from January 2021 and the high temperatures in the air and on the soil surface, on 31.I.2021, in the autumn wheat crop, the moisture content per the soil profile 0-100 cm had optimal values throughout Oltenia. *The soil water reserve* was within limits close to optimal and optimal, on large agricultural areas in Oltenia. The tree-vine species continued their state of vegetative rest in their great majority due to the low thermal minimums, but the hazelnut blossomed. High air temperatures in the plains have led to slow and temporary resumption of growth and development processes, especially in crops established in the optimal period (ANM).

3.a. Thermal regime of February 2021.

The monthly averages of the air temperature were between 1.3°C at Voineasa and 4.0°C at Dr. Tr. Severin, and their deviations from the normal values were between 2.7°C at Tg. Logrești and 3.9°C at Caracal. According to the Hellmann criterion, February was warm (C) throughout Oltenia (Table 4). *The general average of February* calculated for all of Oltenia was 3.0°C , and its deviation from normal was 3.46°C , which confirms that February 2021 was warm (C) in all of Oltenia. The highest daily average for the whole region was registered on 27.II, with an average of 9.92°C , and the average daily maxima for the entire region were 20.3°C . *The monthly minima of air temperature* were recorded on 13, 14, 15 and 17.II (most on 13.II.2021) and were between -13.50°C at Apa Neagră (13 .II.2021) and -7.5°C at Calafat (13.II.2021), and their average for the entire region of -10.4°C .

The highest value of the daily average for the minimum temperatures calculated for the entire region was 6.8°C , on 11.II. After only one day, on the 13th, the lowest average of the daily lows of -10.7°C was registered, which

shows *the intensity of the thermal stress* produced on the crops and biotopes. In 15 days the daily average of lows for the whole region was $\geq 0^{\circ}\text{C}$, which means 15 days of spring⁶ for the whole region.

The cold units were insignificant and ranged between 14.7 at Dr. Tr. Severin and Calafat and 35.5 at Polovragi with an average for the entire region of 22.9. *The heat units* were between 70.9 at Voineasa and 125.8 at Dr. Tr. Severin, with an average for the entire region of 106.3, which from an agrometeorological point of view means a very warm month. *The agrometeorological frost* was not registered in February.

Table. 4. The air temperature regime in Oltenia and the minimum and maximum temperature values at the soil surface in February 2021 (N II = February norms calculated for the period 1901-1990, M II = monthly averages of February 2021; $\Delta = M - N =$ temperature deviation, CH = Hellmann criterion).

No. Crt.	Meteorological Station	Hm	NII	MII	$\Delta = M - N$	CH	Tmax air		Tmin air		Tmax ground		Tmin ground	
							°C	Data	°C	Data	°C	Data	°C	Data
1	Dr. Tr. Severin	77	0,9	4,0	3,1	C	21,1	27	-8,1	13	31,3	26	-12,9	13
2	Calafat	66	0,4	3,6	3,2	C	21,0	27	-7,5	13	22,5	27	-6,6	13
3	Bechet	65	-0,1	3,3	3,4	C	21,7	27	-9,1	17	18,7	27	-5,3	13
4	Bailesti	56	-0,1	3,2	3,3	C	21,1	27	-8,7	13	27,1	26	-10,7	13
5	Caracal	112	-0,7	3,2	3,9	C	21,1	27	-9,4	13	17,6	27	-6,8	13
6	Craiova	190	-0,4	3,3	3,7	C	21,7	27	-10,7	13	24,3	27	-11,5	13
7	Slatina	165	-0,2	3,0	3,2	C	22,0	27	-11,0	13	23,5	27	-9,9	13
8	Bacles	309	-0,9	2,9	3,8	C	20,9	27	-11,4	13	-	-	-	-
9	Tg. Logresti	262	-0,7	2,0	2,7	C	20,7	27	-10,8	15	24,6	27	-11,0	13
10	Dragasani	280	-0,2	3,6	3,8	C	22,2	27	-10,5	13	19,6	27	-6,7	13
11	Apa Neagra	250	-0,6	2,2	2,8	C	21,5	26	-13,5	13	19,5	26	-8,7	13
12	Tg. Jiu	210	-0,4	3,3	3,7	C	22,4	27	-10,3	13	25,6	27	-8,2	13
13	Polovragi	546	-1,4	2,2	3,6	C	20,2	27	-12,8	13	30,5	27	-12,6	13
14	Rm. Valcea	243	0,0	3,5	3,5	C	22,2	27	-10,4	13	38,0	27	-13,1	13
15	Voineasa	587	-2,5	1,3	3,8	C	18,0	25	-11,2	13	-	-	-	-
16	Parang	1585	-	-	-	-	-	-	-	-	-	-	-	-
	Media Oltenia		-0,46	3,0	3,46	C	21,2	-	-10,4	-	24,8	-	-9,5	-
17	Ob. Lotrului	1404	-5,5	-2,7	2,8	C	13,7	26	-20,7	14	-	-	-	-

(Data source processed from the ANM archive)

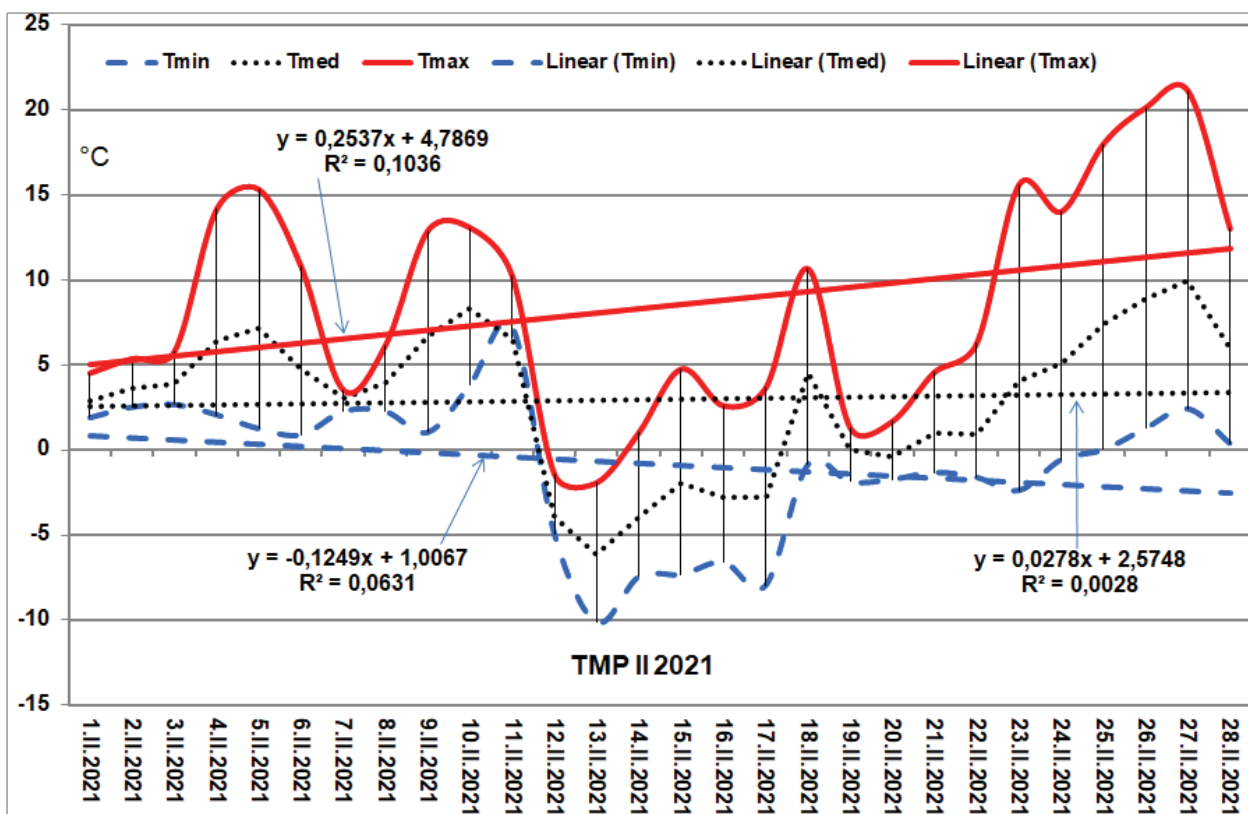


Figure 3. Variation of the parameters that characterize the air temperature (average daily minimums, daily average and average daily maximums, calculated for the entire region) in February 2021. (Data source processed from the ANM archive).

⁶ It is called the spring day, the day when the minimum air temperature $\geq 0^{\circ}\text{C}$.

The monthly maximum air temperatures were recorded on 25, 26 and 27.II.2021 (most on 27.II) and were between 18.0°C at Voineasa (25.II) and 22.4°C at Tg. Jiu (27.II) with an average for the entire region of 21.2°C. In ten days the average daily maximum for the whole region was $\geq 10.0^\circ\text{C}$ and in four days $\geq 15.0^\circ\text{C}$.

The values of 22.0°C recorded at Slatina in the Getic Piedmont and 22.2°C recorded at Drăgășani, constitute an absolute thermal record for this meteorological station for the whole period of meteorological observations.

The graphs of the parameters' variation that characterize the air temperature (daily average minimums, daily average and daily average maximums all calculated for the whole region) in February 2021, had significantly increasing linear trends, except for the minimums that had a slightly decreasing trend (Fig. 3).

At the surface of the soil, the monthly minimum temperatures were recorded in the dates of 9, 10, 13, 25 and 28.II and were between -8.4°C at Rm. Calafat (28.II), and their average for the whole region was -5.5 °C.

The monthly minimums of the soil surface temperature were registered on the 13th and were between -13.1°C at Rm. Vâlcea and -5.3°C at Bechet, and their average for the entire region was -9.5°C. On nine days the average of the minimums for all of Oltenia was positive, which shows that the soil was thawed day and night, and on most days there was an alternation of the phenomenon of frost / thawing on the soil surface.

The monthly maximums of the soil surface temperature were recorded on the dates of 26 and 27.II and ranged from 17.6°C in Caracal (27.II) to 31.3°C in Dr. Tr. Severin (26.II) with an average of 24.8°C for the whole region. All these high values of temperature in the air and soil determined the slow resumption of vegetation phases in all types of agricultural crops but also for the entire vegetation. Thus the hazelnut blossomed even from the first days of January during 20-25.II there was swelling of buds in early fruit trees: almond, apricot, cherry, sour cherry, wax cherry, and on 7.III the first flowers of wax cherry and apricot were reported. The opening of buds for willow, magnolia, privet and rose began on the 1st of March, when the foliage began. These *phenological observations* on the evolution of "heat indicator" plants show an excessively early spring, for the spring of 2021.

3.b. The pluviometric regime of February 2021

The monthly precipitation amounts were between 4.4 l/m² at Bechet and 38.5 l/m² at Apa Neagră, and their deviations from normal were between -87.4% in Bechet and -26.4% in Polovragi. According to the Hellmann criterion, February was excessively rainy (EP) in most of Oltenia (Table 2). *The average monthly quantity* calculated for the whole region was 18.3 l/m², and its percentage deviation from normal was -56.9%, which shows that according to the Hellmann criterion, February was on average excessively dry (ES) for the whole region. The snow layer in February 2021 was insignificant and was recorded in isolation between 20-21.II. Due to the warm weather, the water consumption of the soil and the deficient precipitations, in the autumn agricultural crops on 28.II.2020, the water content on the soil depth 0-100 cm, in the autumn wheat crop, is within satisfactory limits and close to the optimum, on large agricultural areas in Oltenia.

4. Seasonal climatic characteristics of winter 2020-2021

The seasonal averages of the air temperature were between 0.4°C at Voineasa and 3.7°C at Dr. Tr. Severin, and their deviations from normal were between 2.9°C at Apa Neagră and 4.3°C at Craiova. According to the Hellmann criterion, the winter 2020-2021 was very warm (FC) throughout Oltenia. The average season calculated for the entire region was 2.55°C, and its deviation from normal was 3.5°C, which confirms that on average the winter of 2019-2020 was very warm (FC) for the whole region (Table 5). The average of 2.55°C confirms *that the winter 2020-2021 was the fourth very warm winter in the descending order of the averages of the last 60 years.* The first, warmest three winters were: 2006-2007 with an average of 3.44°C, 2019-2020 with an average of 2.89°C and 2015-2016 with an average of 2.88°C. The thermal difference between the warmest winter and the second one is significant, of 0.55°C. We make a special mention for the winter 1982-1983 with an average of 2.05°C, as the *only winter of the last century with an average of >1.7°C and the only very warm winter recorded before the year 2000.* All this shows a warming Exceptional winter season occurred especially after 1982 and accelerated since 1998 and the warming process in the last century was slow.

The seasonal rainfall amounts were between 103.3 l/m² at Băcleș and 1/m² at Apa Neagră, and their percentage deviations from normal were between 19.8% in Bechet and 98.1% in Drăgășani (Table 5). According to the Hellmann criterion, the winter 2020-2021 was excessively rainy (EP) in most of Oltenia except for a restricted area in Bechet (rainy -P) and the areas of Dr. Tr. Severin, Caracal and Slatina where it was very rainy (FP). *The average seasonal rainfall calculated for the entire Oltenia region* was 214.4 l/m², and its percentage deviation from normal was 54.1%, which according to the Hellmann criterion confirms that the winter 2020-2021 was excessively rainy (EP) on average for the whole region.

DISCUSSIONS

Throughout the winter, only **three cooling intervals** were recorded: 1-3.XII.2020 (three days) with the maximum intensity in the dates of 1 and 2.XII, 16-22.I.2021 (7 days) with the maximum intensity on the dates of 18 and 19.I and 12-17.II (6 days) with the maximum intensity on the date of 13.II, all these totaling 16 days. In contrast to the cold periods, the heating intervals were: 23-25.XII (3 days), 29-31.XII (3 days); 1-7.I (7 days), 23-24.I (2 days), 29-31.I (3 days); 4-6.II (3 days), 9-11.II (3 days), 18.II, 23-28.II (6 days), all of which total 31 days, ie almost double the number of days with cooling weather. In the other 43 days the average temperature was close to the normal thermal and positive. Therefore, the warm winter period amounted to 74 days (82.2%) of the 90 calendar days. The warming period of the weather at the end of February (23-28.II) marked the most intense warming of the weather and the longest because it extended until 9.III. **The lowest average of the monthly minimum temperatures** calculated for the whole of Oltenia, was recorded in January in the amount of -11.1°C , very close to that of February which was -10.4°C . **The highest monthly average of thermal maximums**, calculated for the whole of Oltenia was 21.2°C and was recorded in February. **The cold units** for the whole winter were between 23.7 at Dr. Tr. Severin and 117.8 at Voineasa, and their average for the whole winter was 22.9. **The highest monthly average of cold units** for the entire region was recorded in January and was 25.3 with only 2.4 higher than in February. The lowest monthly average of cold units for the entire region was recorded in December and was 6.3. **The heat units** for the whole winter were between 144.7 in Voineasa and 358.2 in Dr. Tr. Severin and their average for the whole region was 282.8, ie 12.3 times higher than that of the cold units. All this confirms that the winter 2020-2021 was very warm (FC). The snow layer was insignificant and transient, and the largest thickness of 16 cm for a short time at Polovragi, was recorded on 8.XII.2020 (in Calafat) and 11.I.2021 (in Calafat and Băilești), and the largest expansion on 11.I.2021 (Fig. 4).

We will further analyse the synoptic causes of the most intense cooling of the weather this winter recorded on 18.I.2021 and of the most intense heating produced on 27.II. 2021.

Table 5. The overall rainfall and thermal regime of winter 2020-2021. Hm = altitude of the weather station, W'20-'21 = average winter temperature values 2020-2021 ($^{\circ}\text{C}$), NW = normal values of winter temperature averages in winter ($^{\circ}\text{C}$), $\Delta = \text{W-N}$ = average temperature deviations compared to normal ($^{\circ}\text{C}$) CrH = Hellmann criterion; SW = sum of precipitation in winter 2019-2020 (l/m^2), N-W = normal values of precipitation in winter (l/m^2), $\Delta = \text{S-N}$ = deviations from normal (l/m^2), $\Delta\%$ = percentage deviations from normal).

Nr. crt.	Stația meteorologică	Hm	Regimul termic ($^{\circ}\text{C}$)					Regimul pluviometric (l/m^2)				
			W'20-'21	NW	$\Delta = \text{W-N}$	CrH	SW	NW	$\Delta = \text{S-N}$	$\Delta\%$	CrH	
1	Dr. Tr. Severin	77	3,7	0,4	3,3	FC	215,5	160,5	55,0	34,3	FP	
2	Calafat	66	3,1	-0,1	3,2	FC	206,5	123,9	82,6	66,7	EP	
3	Bechet	65	3,0	-0,6	3,6	FC	125,3	104,6	20,7	19,8	P	
4	Băilești	56	2,9	-0,7	3,6	FC	191,5	121,4	70,1	57,7	EP	
5	Caracal	112	2,7	-1,2	3,9	FC	155,2	108,7	46,5	42,8	FP	
6	Craiova	190	3,3	-1,0	4,3	FC	180,0	109,7	70,3	64,1	EP	
7	Slatina	165	2,7	-0,8	3,5	FC	157,4	117,2	40,2	34,3	FP	
8	Băcleș	309	2,3	-1,4	3,7	FC	103,3	149,3	-46,0	-30,8	FS	
9	Tg. Logrești	262	2,1	-1,1	3,2	FC	210,5	121,7	88,8	73,0	EP	
10	Drăgășani	280	2,9	-0,6	3,5	FC	226,0	114,1	111,9	98,1	EP	
11	Apa Neagră	250	1,9	-1,0	2,9	FC	424,0	219,6	204,4	93,1	EP	
12	Tg. Jiu	210	2,8	-1,0	3,8	FC	254,1	169,9	84,2	49,6	EP	
13	Polovragi	546	1,8	-1,5	3,3	FC	286,9	153,4	133,5	87,0	EP	
14	Rm. Vâlcea	243	3,0	-0,6	3,6	FC	218,3	120,1	98,2	81,8	EP	
15	Voineasa	573	0,4	-3,0	3,4	FC	160,5	141,8	18,7	13,2	PP	
16	Parâng	1585	-	-	-	-	268,0	160,0	108,0	67,5	EP	
	Media Oltenia	-	2,6	-0,9	3,5	FC	211,4	137,2	74,2	54,1	EP	
17	Ob. Lotrului	1348	-3,2	-5,5	2,3	C	313,4	-	313,4	-	-	
18	Petroșani	607	-	-1,7	-	-	237,3	139,5	97,8	70,1	EP	

(Data source processed from the ANM archive)

The synoptic causes that determined the cooling of the weather on 18.I 2021

In the interval 16-22.I a cold wave affected Eastern Europe, and for Oltenia the maximum cooling intensity occurred on 18.I.2021, when the thermal minimums in the air were between -14.7°C at Voineasa and -6.8°C at Dr. Tr. Severin, and in the mountain area the thermal minimum of -22.8°C at Ob. Lotrului was the lowest thermal minimum of the whole winter. Climate variability in the winter of 2021 was particularly high for the entire Northern Hemisphere (Figs 5; 6).

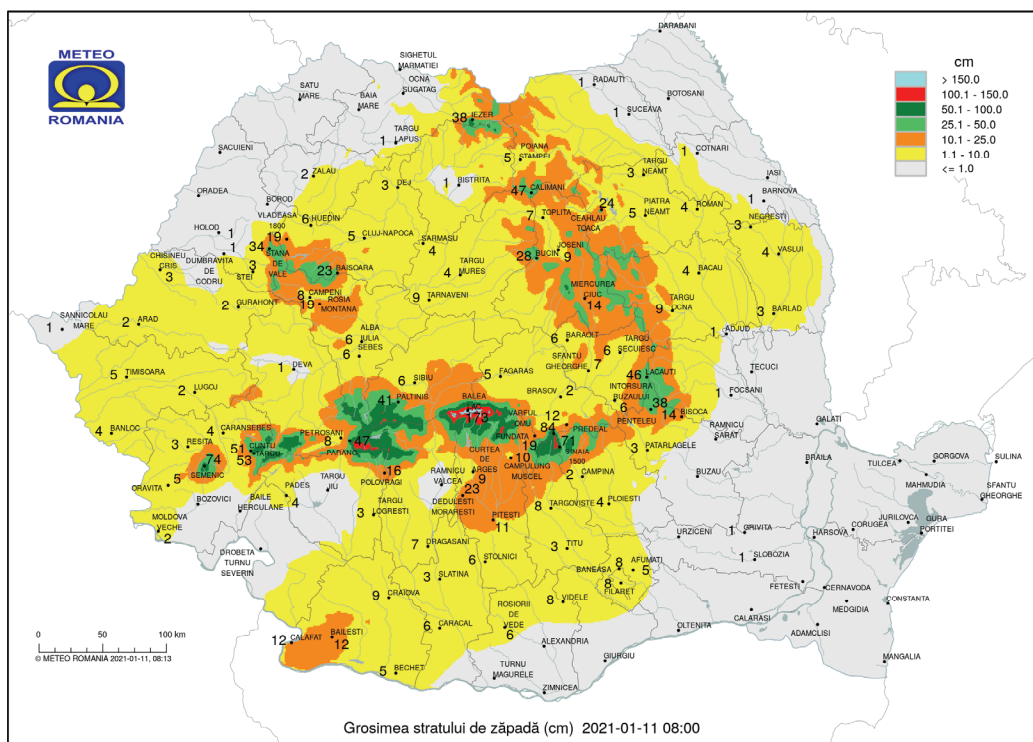


Figure 4. Snow cover from 11.I.2021 at 06.UTC (ANM Source).

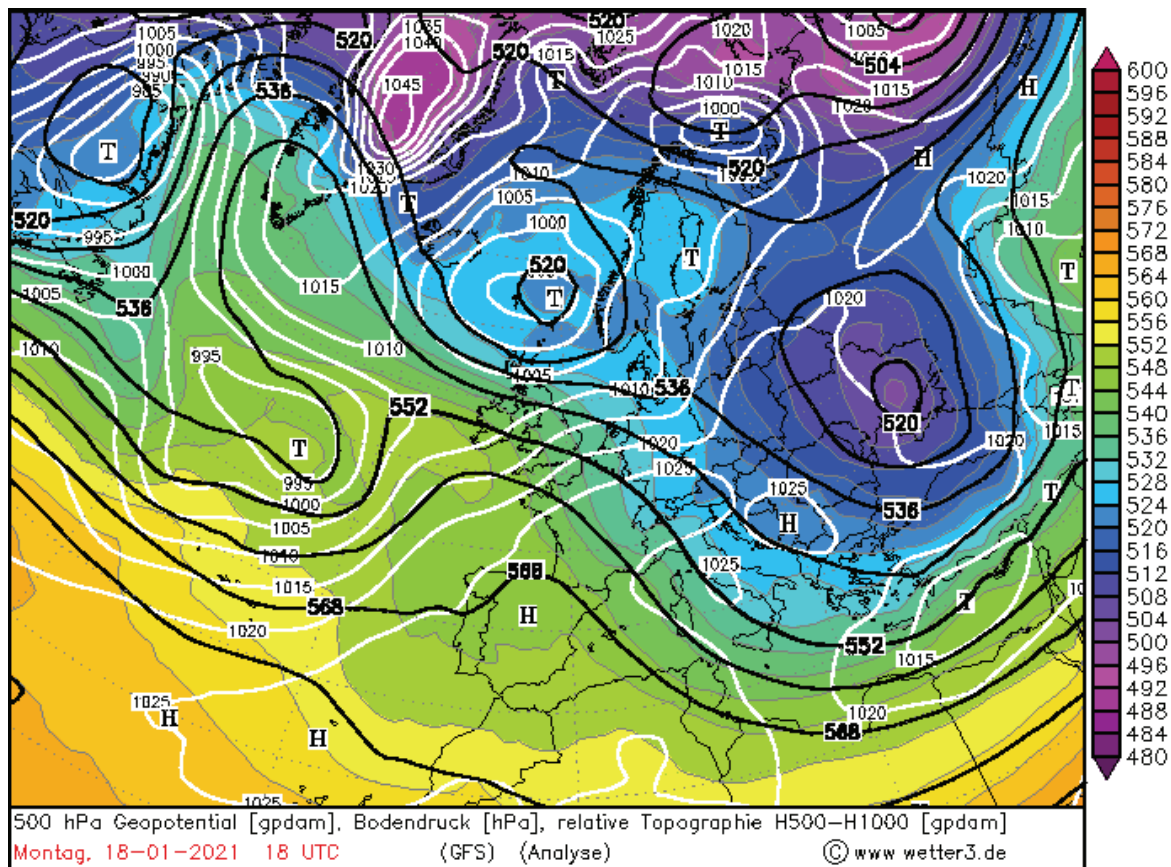


Figure 5. The synoptic situation at the level of the terrestrial surface (atmospheric pressure field) superimposed with the synoptic situation from altitude (geopotential field at the level of 500 hPa - about 5000 m altitude) and the field of relative baric topography (TR 500/1000) from 18.I.2021 at 18 UTC. (www.wetter3.de).

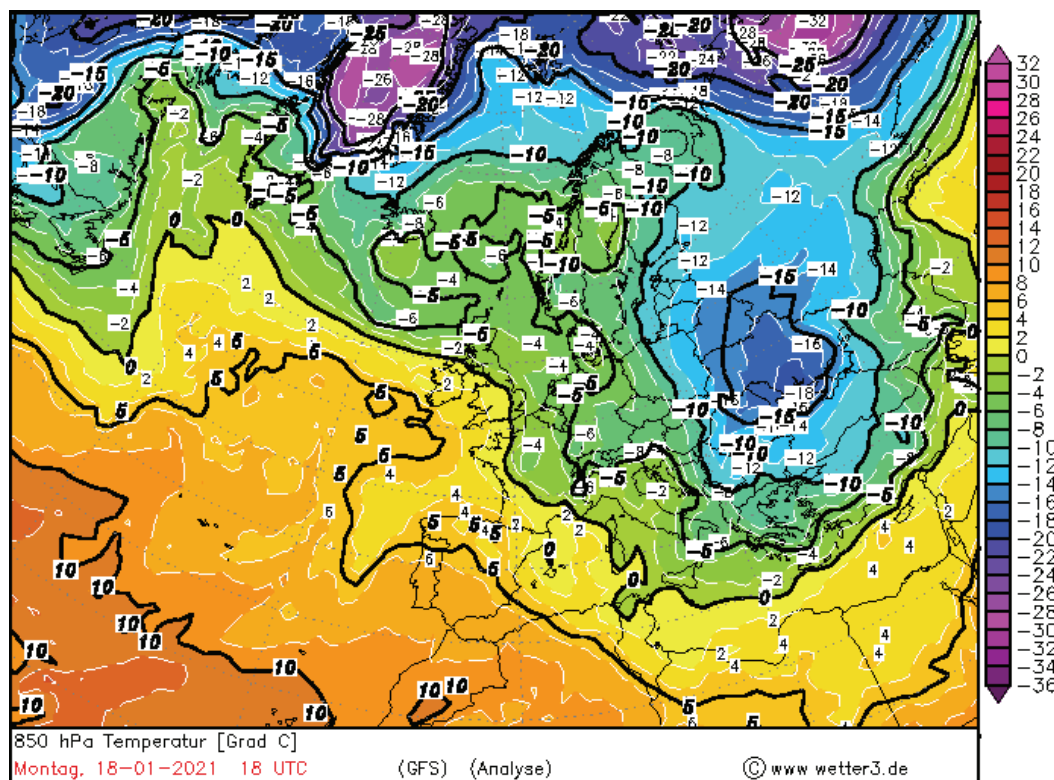


Figure 6. The temperature field at the level of the geopotential surface at the level of 850 hPa - about 1500 m altitude) from 18.I.2021 at 18 UTC (www.wetter3.de).

Thus, on 10.I.2021, a heat wave with maximums of 28°C determined the people of Greece to overcome the restrictions of the pandemic and to go out in large numbers to the beach or in the parks (AFP, taken over by Agerpres). The temperature at Chania (Athens National Observatory), on the southern island of Crete, reached 28.3°C around noon, being one of the highest temperatures recorded in January in the last 50 years.

At the same time, in the south of the continent, but further west, Spain is facing the biggest snowfalls in recent decades, brought by Storm Filomena. The average temperatures in Greece at this time of year are around 15°C. In Athens, the air temperature reached 22.0°C, and people went to the beach, in the markets and parks of the capital. The warm wind from Africa also brought a lot of dust and the temperature remained high until 13.I. (<https://www.digi24.ro/stiri/externe/val-de-caldura-in-grecia-oamenii-au-iesit-la-plaja-sfidand-restrictiile-1431780>).

The initiation of cold air advection over Europe took place on the 1.I, but the evolution was slow, and in front of the cold air, as is usually the case, warm air advections took place, which explains the above. The maximum intensity of advection as well as the maximum extension of the cold Arctic air over Eastern Europe, occurred on 18.I. At 18 UTC on 18.I.2021, at the level of the land surface, the distribution of the baric centers was as follows: the anticyclonic belt extended over most of Europe, from the Azores Islands was also united with the Eastern European (which further, towards the east, it connected with the Russian-Siberian anticyclone) (Figure 5). To the north of this anticyclonic belt is the field of Icelandic cyclones and the Greenlandic Anticyclone. In the lower troposphere, for Oltenia, the air circulation was from the north-western sector, and the polar polar air mass cold + arctic (cPk + A). At an altitude of 500hPa the air circulation was poorly blocked (the 544 hPa isohypsis has the shape of the letter "Ω").

The synoptic causes that determined the warming of the weather on 27.II 2021. At the level of 850 hPa (about 1500 m altitude) the values of the temperature field above Europe indicate a particularly cold air mass area located above Romania, north of the Black Sea with values of -18.0°C, and above Oltenia values of -10.0 -12.0°C (Figure 6). At this time almost all of Europe was occupied by cold air, except in western France and the Iberian Peninsula, and the southern limit of cold air advection was located in the middle part of the Mediterranean Sea and reached North Africa in the Cape Tunis area. The wave from 16-22.I was the most intense in the winter 2020-2021.

The synoptic causes that determined the warming of the weather on 27.II 2021

At the end of February in the interval (23-28.II) a wave of warm air covered a large part of Europe being the most intense warming of the weather and the longest extending until 9.III. For Oltenia, the maximum heating intensity occurred on 27.II.2021 (Fig. 7).

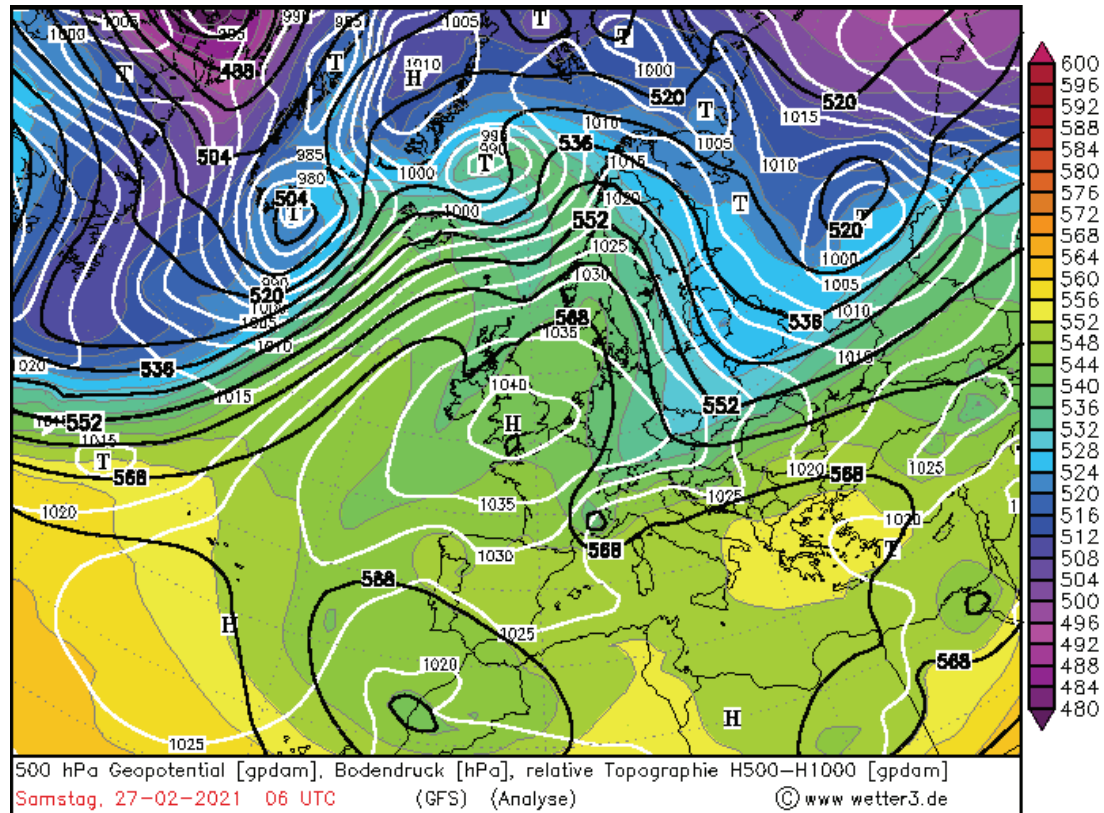


Figure 7. Synoptic situation at the ground surface (atmospheric pressure field) superimposed with the synoptic situation at altitude (geopotential field at 500 hPa - about 5000 m altitude) and the field of relative baric topography (TR 500/1000) from 27 .II.2021 at 06 UTC (www.wetter3.de).

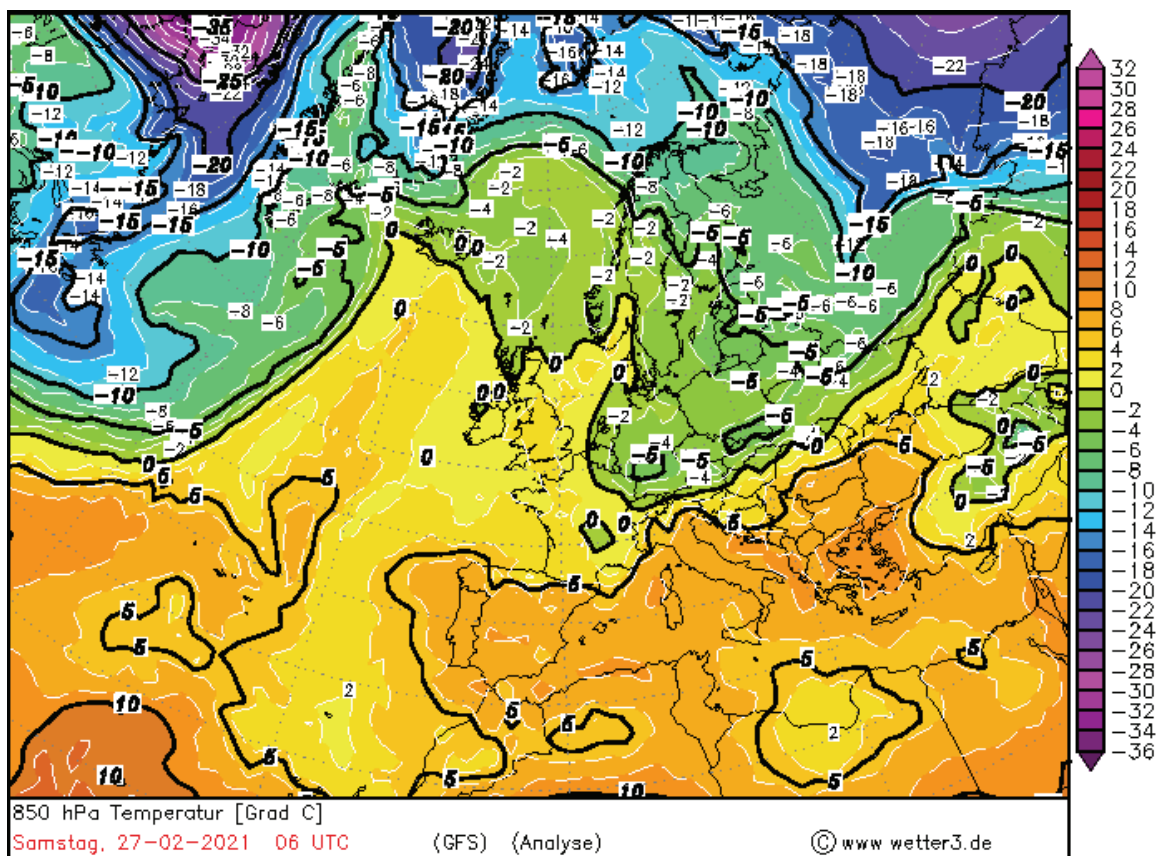


Figure 8. The temperature field at the level of the geopotential surface at the level of 850 hPa - about 1500 m altitude) from 27.II.2021 at 18 UTC (www.wetter3.de).

At this time, at the surface level, the distribution of baric centers over Europe was as follows: the anticyclonic belt (usually present in winter over Eurasia), had a center above the British Isles with center values of over 1040 hPa and was united over Romania and the Black Sea with Eastern European anticyclone (Figs. 7; 8). A cyclone originally from Iceland was present in the Eastern European Plain. *In the lower troposphere at 500 hPa* (about 5000 m altitude), the air circulation was blocked (the isohypsis of 568 hPa has the shape of the letter "Ω"). *At the level of 850 hPa* (about 1500 m altitude) the air temperature field had values of 6-7° C above the south of Romania. The warm air above Europe extended north to the south of the Scandinavian Peninsula and the north of England, and at its northernmost point it slightly exceeded the 70° N parallel (Figure. 8). The coming of spring process has been intense since 1.II and in Figure 8 it is very well illustrated how it occurs: warm air is advected over Europe from two directions – from the Atlantic Ocean and from the Mediterranean Sea, encompassing the continent “like in a pair of tongs”, which explains the quick and early arrival of spring.

CONCLUSIONS

The winter of 2020-2021 was a **very warm winter** (CF) with an average of 2.55°C and a deviation from normal of 3.5°C, which means **the fourth warmest winter in the history of meteorological observations**, after the winters 2006-2007 with an exceptional average of 3.44°C and a deviation of 4.39°C, which was **the absolute climatic record of warm winters**, 2019-2020 with an average of 2.89°C and a deviation of 3.84°C and 2015-2016 with an average of 2.88°C and the deviation of 3.83°C. Due to the characteristics presented in May, the winter 2020-2021 can be considered as being the third Mediterranean winter in southwestern Romania⁷. In the winter of 2020-2021 **the snow layer was present 12 days in January and one day, isolated** in February 9-20.I, and the maximum thickness was 16 cm at Polovragi.

The winter of 2020-2021 was very warm as a whole with **December warm (C) with an average of 3.23°C** and deviation of 3.05°C, January 2021 was warm with an average of 1.46°C and deviation from normal of 4.03°C. **December 2020 was the third warmest month** in the history of meteorological observations, in descending order of the average monthly temperature values calculated for the entire region, after December 2015 with an average of 5.19°C (**absolute climate record**) and December 1979 with an average of 3.21°C, surpassing December 2019. January 2021 was the 5th warm month in descending order of the values of the monthly average temperature for the entire region, **the absolute climate record is held by January 2007 with an average of 4.73°C**. February 2021 was warm with an average of 2.97°C and a deviation from normal of 3.43°C.

The cold units for the whole winter were between 23.7 at Dr. Tr. Severin and 117.8 at Voineasa, and their average for the whole winter was 22.9. **The highest monthly average of cold units** for the entire region was recorded in January and was 25.3 with only 2.4 higher than in February. **The lowest monthly average of cold units** for the entire region was recorded in December and was 6.3.

The heat units for the whole winter were between 144.7 in Voineasa and 358.2 in Dr. Tr. Severin and their average for the whole region was 282.8, i.e. 12.3 times higher than that of the cold units. All this confirms that the winter 2020-2021 was very warm (FC). The snow layer was insignificant and transient, and the largest thickness of 16 cm for a short time at Polovragi, was recorded on 8.XII.2020 (in Calafat) and 11.I.2021 (in Calafat and Băilești), and the largest expansion on 11.I.2021 (Figure 4). They confirm that the winter 2020-2021 was very warm from an agrometeorological point of view, and the agrometeorological frost was completely absent.

The pluviometric regime was on excess, with the average for the entire region of 211.4 l/m² and the percentage deviation from the normal of 54.1. February 2021 was excessively dry with the average for the entire region of 18.3 l/m² and the percentage deviation from normal of -56.9%.

We thus record **the third Mediterranean winter in Oltenia**, with a difference of the average seasonal temperature of 0.89°C from the first, which confirms **the continuation of global warming at regional level**, although the El Niño climate process was absent and a climate process La Niña was moderately present, and solar activity was minimal. These results show the continued expansion to the north of the influence of the Mediterranean climate. The winter of 2020-2021 was warm and with a thin and transient layer of snow, and the coronavirus pandemic (**2019-nCoV**) continued around the globe (11.III.2020 - WMO Declaration) and affecting people with serious consequences for the economy countries. A warm winter is a special climatic risk that can have multiple serious consequences on large areas of the Earth.

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⁷ The term **Mediterranean winter** was first introduced in 2007 (BOGDAN et al., 2007), regarding the winter 2006-2007, signifying a warm winter, almost devoid of snow or with an insignificant layer and short duration.

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