THE MEDITERRANEAN WINTER 2021-2022 IN SOUTHWESTERN ROMANIA IN THE CONTEXT OF CLIMATE CHANGES

MARINICĂ Andreea Floriana, MARINICĂ Ion, CHIMIŞLIU Cornelia, DIACONU Luminița

Abstract. Global warming continued during 2021, so after the warm winter of 2020-2021, followed by a cold spring, a hot (C) and very dry (FS) summer, and after a warm (CL) and dry (S) autumn, the winter 2021- 2022 was very hot (CF), with a seasonal average of 2.61°C and a deviation from normal of 3.56°C, as the largest seasonal deviation for all seasons of 2021. December was warm with a monthly average of air temperature of 2.38°C and a deviation from normal of 2.2°C. January 2022 was warm (C) with an average of 1.48°C and a deviation from normal of 4.05°C, and February 2022 was warm (C) with an average of 3.97°C and deviation from of normal 4.43°C. The snow cover was insignificant over small areas and lasted for a few hours. The average number of heat units for the entire Oltenia was 270.7. The seasonal average of precipitation amounts was 136.5 l/m^2 and the percentage deviation from normal was 0.5%, being on average normal rainfall (N). Thus, the winter of 2021-2022 was the third Mediterranean winter in descending order of the seasonal winter averages in Oltenia.

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

Rezumat. Iarna mediteraneeană 2021-2022 în sud-vestul României în contextul schimbărilor climatice. În cursul anului 2021 încălzirea climatică a continuat, astfel după iarna caldă 2020-2021, a urmat primăvara rece, vara caldă (C) și foarte secetoasă (FS) și după toamna călduroasă (CL) și secetoasă (S), apoi iarna 2021-2022 a fost foarte caldă (FC) cu media anotimpuală de 2,61°C și abaterea față de normală de 3,56°C fiind cea mai mare abatere anotimpuală pentru toate anotimpurile anului 2021. Luna decembrie a fost caldă cu media lunară a temperaturii aerului de 2,38°C și abaterea față de normală de 2,2°C. Luna ianuarie 2022 a fost caldă (C) cu media de 1,48°C și abaterea față de normală de 4,05°C, iar luna februarie 2022 a fost caldă (C) cu media de 3,97°C și abaterea față de normală de 4,43°C. Stratul de zăpadă a fost nesemnificativ pe areale restrânse și cu durată efemeră de câteva ore. Media unităților de căldură pentru întreaga Oltenie a fost de 270,7. Media anotimpuală a cantităților de precipitații a fost de 136,5 l/m^2 și abaterea procentuală față de normală de 0,5%, fiind în medie normală pluviomteric (N). Astfel iarna 2021-2022 a fost a treia iarnă mediteraneeană în ordinea descrescătoare a mediilor anotimpuale de iarnă în Oltenia.

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

INTRODUCTION

Globally, the year 2021 was ranked 6th in the ranking of the hottest years in the history of meteorological measurements equal to 2018 (NOAA, quoted by DPA). The average temperature for 2021 was 1.51°C higher than the twentieth century average. The year 2021 was the 45th consecutive year in which the global temperature rose above average, which means that globally it was not a colder year than the average of 1976. All the years between 2013 and 2021 are among the hottest 10 years in the history of meteorological measurements since 1880. The same conclusion was reached by the Berkeley Earth research organization as 2021 was ranked 6th among the warmest years in the history of measurements. The European Copernicus Global Warming Monitoring System has concluded that the last seven years have been the warmest in the history of meteorological measurements (2015-2021). The year 2021, as well as the years 2015 and 2018, was among the least warm years of the last seven years (Copernicus service). In Europe, the summer of 2021 was the warmest summer in the history of meteorological measurements - exceeding the maximum values recorded in the summers of 2010 and 2018 - and reaching a record temperature of 48.8°C in Sicily (0.8°C higher than the previous record). The year 2021 was marked by extreme weather events - floods that hit hard Belgium, the Netherlands and Germany. On the west coast of the United States and in Canada, wildfires have ravaged large areas and severely affected air quality. Heavy and repeated fires in Greece have caused immense damage and human casualties. "2021 was another year of extreme temperatures, with the hottest summer in Europe, heat waves in the Mediterranean and unprecedented high temperatures in North America" (Copernicus director Carlo Buontempo). (***. http: //stiri.tvr.ro/anul-2021-a-fost-unul-dintre-cei-mai-caldurosi-ani-din-istoria-masuratorilor-meteorologio_898194.html#view.)

In Oltenia, the average annual temperature in 2021 was 11.37 ° C with a deviation from normal of 1.1 ° C, which means that it was a warm year (C) and the global warming continued. After the hot (C) and very dry (FS) summer, the warm (CL) and dry (S) autumn followed, and the warm weather extended during the winter of 2021-2022.

The paper is part of a series of extensive studies on climate variability in southwestern Romania and the effects of global warming (BOGDAN et al., 2007; 2008; MARINICĂ & CHIMIŞLIU, 2008; BOGDAN & MARINICĂ, 2009; BOGDAN et al., 2010; SANDU et al., 2010; MARINICĂ et al., 2010; 2011; 2012; 2013; BOGDAN et al., 2014; MARINICĂ & MARINICĂ, 2016) being useful to all those interested in the evolution of the climate in this part of Romania. We will further analyse the multiple aspects of the climate variability in Oltenia which are characteristic of the winter 2021-2022 and the consequences on agricultural crops, biotopes, economy and environment in general.

MATERIAL AND METHOD

To carry out the work we used the results of daily processing, with special software from the weather forecast process, the ANM data archive, the maps currently made in the operative activity, the ones on the internet provided by the international analysis and forecasting centres and the ones from ANM[1] Bucharest. We used Office features to create tables and graphs. We used the Hellmann criterion and the comparison with the normal averages of air temperature calculated for the last century (1901-1990). The comparison with the norms of the last 30 years is not conclusive because the norms for the last 30 years are sliding averages with an increasing linear trend as well as the averages being compared. The paper analyses the climatic variability from the warm winter 2021-2022 in southwestern Romania, based on the thermal and pluviometric regime of December 2021, January and February 2022 and the overall thermal and pluviometric regime of winter 2021-2022. The effects on the environment and biotopes are also analysed.

RESULTS

1.a. The thermal regime of December 2021. The monthly averages of air temperature were between 0.8°C in Voineasa and 3.9°C in Calafat, and their deviations from normal were between 1.4°C in Polovragi and 2.9°C at Calafat. According to the Hellmann criterion[2], December 2021 was warm (C) in the Oltenia Plain, in the Getic Piedmont at Slatina, in the Olt Corridor at Drăgășani and in the Voineasa Intramontane Depression, and warm (CL) in the area of hills and Subcarpathian depressions. ***The average monthly air temperature*** calculated for the entire Oltenia region was 2.4°C, and its deviation from normal was 2.22°C, which according to the Hellmann criterion shows that December 2021 was a warm month (C) on average for the whole Oltenia region (Table 1).

The highest daily averages of air temperature calculated for the whole of Oltenia were recorded at 1.XII (10.1°C), 2.XII (10.3°C) and ***25.XII (12.9°C).***

Monthly maximum air temperature. Most of them were registered on 25.XII.2021 and ranged from 9.9°C at Polovragi (on 2.XII) to 17.3°C at Bechet on 25.XII, and their average for the entire region was 13.9°C. ***The monthly minima of air temperature*** were recorded on the 22nd and 23rd. 2021 and were between -12.6°C at Târgu Logrești (in 23.XII) and -6.0°C (on the same date). ***The average monthly temperature*** for the whole region was 9.1°C. ***At the surface of the soil, the monthly minimum temperatur***es were recorded on the dates of 22, 23 and 24.XII and were between -12.2°C at Râmnicu Vâlcea and -3.7°C at Drăgășani, and their average for the whole region it was -8.2°C. ***Most monthly surface temperature maxima*** were recorded on 25.XII and ranged from 10.4°C in Drăgășani to 20.6°C in Caracal, with an average for the entire region of 15.0°C. ***The heat units***[3] in December 2021 ranged from 41.3 in Voineasa and 123.9 in Calafat, and the average for the entire region was 81.2. ***The cold units*** in December 2021 were between 2.8 in Calafat and 20.2 in Voineasa and Târgu Logrești and the average for the entire Oltenia region was 11.3.

This shows that December 2021 was hot and the heat units were much larger than the cold ones which were insignificant. ***The frost units*** were registered between 22-23.XII and were between 0.6 per Târgu Jiu and 3.5 at the Black Water with an average for the entire region of 2.3, ie. insignificant. As a result, biotopes and biocenoses[4] remained active throughout December 2021. The autumn crops remained in a stage of active vegetation, continuing their slow development.

[1] ANM= Nnational Meteorological Administration

[2] Hellmann criterion for monthly averages of air temperature: Δt≤ -10.0°C = >excessive cold (ER); -9.9 ≤Δt≤ -5.0°C = >very cold (FR); -4.9° -2.0°C = (cool (R); -1.9 ≤Δt≤-1.0°C = >cool (RC); -0.9 tt + 0.9°C = (normal (N); 1.0≤Δt≤ 1.9°C = >heat (CL); 2.0 ≤Δ 4.9°C = >heat (C); 5.0 ≤Δ 9.9°C = > very hot (HR); Δt≥10.0°C = > excessive heat (EC).

[3] *The degree of winter harshness* in agrometeorology (winter type) is classified by the sum of units of agrometeorological frost (differences between the values of minimum daily temperatures <-15°C and the critical agroclimatic threshold of -15.0°C, between XII-II). Therefore a unit of agrometeorological frost 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 et al., 2010). Cold units for the entire cold season are calculated as average daily temperatures ≤ 0°C, during November-March. A cold day is a 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 Heat units (daily average temp ≥0°C). For diagnoses and weather forecasts intended for the public through frost, a temperature that is understood to be ≤-10.0°C and differs from the agrometeorological frost (temperatures ≤ -15°C), as the plants are better adapted to the climatic conditions (due to the their cellular structure and specific biotic processes). Starting with 21.II.2022, ANM redefined the agrometeorological frost for temperatures ≤-10°C, aspect due to a long series of warm winters in which the agrometeorological frost after the old thermal limit of -15°C had disappeared. The units of frost are calculated analogously according to the new limit.

[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://en.wikipedia.org/wiki/Biocenosis%C4%83).

Table 1. The air temperature regime in Oltenia and the minimum and maximum surface temperature values in December 2021 (N XII = December norms calculated for the period 1901-1990, M XII = monthly averages of December 2021; Δ = MN = deviation temperature, CH = Hellmann criterion).

Meteorological Station	Hm	NXII	MXII	Δ=M-N	CH	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
Dr. Tr. Severin	77	1,4	3,8	2,4	C	13,8	31	-7,0	23	16,3	31	-8,3	24
Calafat	66	1,0	**3,9**	**2,9**	C	17,1	25	**-6,0**	23	17,5	25	-4,7	24
Bechet	65	0,4	3,0	2,6	C	17,3	25	-8,8	23	12,7	25	-5,6	24
Băileşti	56	0,4	2,9	2,5	C	16,5	25	-7,9	23	19,3	25	-6,2	23
Caracal	112	-0,1	2,6	2,7	C	15,8	25	-7,7	22	**20,6**	25	-7,5	22
Craiova	190	0,1	2,4	2,3	C	14,7	25	-7,8	23	16,2	25	-9,0	22
Slatina	165	0,3	2,5	2,2	C	15,2	25	-9,0	22	13,5	25	-7,1	22;23;24
Bâcleş	309	-0,4	2,0	2,4	C	13,4	25	-7,8	23				
Tg. Logresti	262	0,1	1,6	1,5	CL	13,7	25	***-12,6***	23	13,2	8	-10,4	23
Drăgăşani	280	0,6	2,6	2,0	C	15,3	25	-7,3	22	***10,4***	25	**-3,7**	23;24
Apa Neagră	*250*	*0,1*	*1,9*	*1,8*	CL	*12,8*	*25*	-12,0	*23*	*12,4*	*8*	*-8,7*	*23*
Tg. Jiu	210	0,1	2,0	1,9	CL	12,8	25	-10,6	23	14,9	25	-11,9	23
Polovragi	546	0,1	1,5	***1,4***	CL	9,9	2	-10,8	23	14,5	2	-11,1	24
Rm. Vâlcea	243	0,5	2,4	1,9	CL	13,0	25	-9,0	23	14,1	12	***-12,2***	23
Voineasa	587	-1,9	***0,8***	2,7	C	*7,7*	3	-12,4	23				
Parâng	1585												
Average Oltenia	-	0,18	2,4	2,22	C	13,9		-9,1		15		-8,2	
Ob. Lotrului	1404	-4,9	-2,6	2,3	C	4,3	2	-19,1	23				
Petroşani						9,7	2	-12,7	23	8,9	2	-11,8	23

(Source: data processed from the ANM archive)

Vernalization[5] occurred during the cold spells of December 2021, January and February 2022.

The graphs of the parameters' variation that characterize the air temperature (daily averages, daily minimums and daily maximums) have decreasing linear trends (Fig. 1). There were two significant warm-up intervals: 1-3.XII.2021 and 24-26.XII.2021, totalling 6 days. All daily averages of air temperature calculated for the entire region were positive except for 23.XII (-0.6°C). So in December 2021 there was ***only one winter day***[6] on average for the whole region on the 23rd.

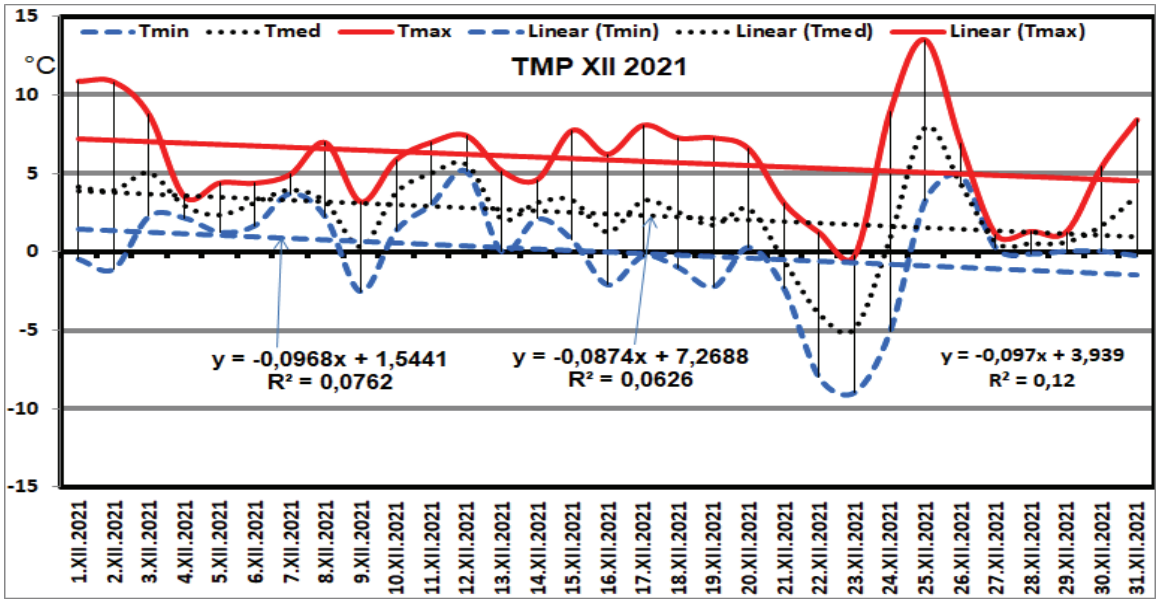

Figure 1. The variation of the parameters that characterize the air temperature (average daily minimums, daily average and average daily maximums, calculated for the entire region) in December 2021 (Source: data processed from the ANM archive).

1.b. The rainfall regime of December 2021

The monthly precipitation amounts ranged from 56.2 l/m^2 at Bechet in the extreme south to 170.2 l/m^2 in the Apa Neagră in the Subcarpathian Depression (Table 2). The percentage deviations of the monthly precipitation amounts from normal were between 31.0% in Băileşti in Câmpia Olteniei and 171.7% in Apa Neagră. According to the Hellmann criterion, December was excessively rainy (EP) in most of Oltenia.

[5] ***Vernalization*** is the acquisition or acceleration of flowering capacity under the influence of exposure to low temperatures.
[6] It is called a *winter day, the day when the air temperature is <0°C.*

Table 2. Amounts of precipitation recorded in winter 2021-2022 (Σ), compared to normal values[7] (N); Δ% = percentage deviation from normal, CH = Hellmann criterion.

No.	Meteorological Station	Hm	December 2021				January 2022				February 2022			
			ΣXII	N	Δ%	CH	Σ I	N	Δ%	CH	ΣII	N	Δ%	CH
1	Dr. Tr. Severin	77	105,4	61,2	72,2	EP	38,7	51,4	-24,7	S	13,6	47,9	-71,6	ES
2	Calafat	66	66,5	45,5	46,2	FP	21,7	40,4	-46,3	FS	7,4	38,0	-80,5	ES
3	Bechet	65	***56,2***	36,3	54,8	EP	18,6	33,5	-44,5	FS	9,0	34,8	-74,1	ES
4	Băileşti	56	61,3	46,8	***31,0***	FP	19,6	38,5	-49,1	FS	9,8	36,1	-72,9	ES
5	Caracal	112	63,3	39,5	60,3	EP	15,5	34,7	-55,3	ES	***6,8***	34,5	-80,3	ES
6	Craiova	190	66,4	41,8	58,9	EP	***12,5***	37,5	-66,7	ES	7,9	30,4	-74,0	ES
7	Slatina	165	86,9	42,8	103,0	EP	14,0	36,0	-61,1	ES	8,9	38,4	-76,8	ES
8	Bâcleș	309	63,7	54,7	***16,5***	PP	9,1	50,5	-82,0	ES	6,0	44,1	-86,4	ES
9	Tg. Logreşti	262	117,8	44,8	162,9	EP	23,4	35,9	-34,8	FS	18,5	41,0	-54,9	ES
10	Drăgăşani	280	103,6	44,6	132,3	EP	20,4	34,1	-40,2	FS	20,7	35,4	-41,5	FS
11	Apa Neagră	250	**170,2**	82,3	106,8	EP	**55,9**	70,9	***-21,2***	S	**23,2**	66,4	-65,1	ES
12	Tg. Jiu	210	117,9	64,0	84,2	EP	37,9	53,9	-29,7	S	20,0	52,0	-61,5	ES
13	Polovragi	546	152,4	56,1	171,7	EP	35,6	48,9	-27,2	S	19,4	48,4	-59,9	ES
14	Rm. Vâlcea	243	119,8	46,2	159,3	EP	12,8	35,5	-63,9	ES	11,1	38,4	-71,1	ES
15	Voineasa	587	72,3	55,1	31,2	FP	0,4	42,7	***-99,1***	ES	6,8	44,0	-84,5	ES
16	Parâng	1585	120,2	54,6	120,1	EP	85,6	57,7	48,3	FP	29,4	47,7	-38,4	ES
	Average Oltenia	-	96,5	51,0	89,1	EP	26,4	43,9	-39,9	FS	13,7	42,3	-67,7	ES
17	Ob. Lotrului	1404	156,1				85,7				30,0			

(Source: data processed from the ANM archive)

The average amount of precipitation for the entire Oltenia region was 96.5 l/m^2, and its percentage deviation from normal was 89.1%, which shows that December was excessively rainy (EP). Therefore, between October and December, the secondary rainfall maximum was recorded for 2021. ***December 2021 was the second wettest month of 2021 after January 2021*** with an average for the entire region of 107.9 l/m^2 (the only monthly average for the whole of Oltenia, which has exceeded 100 l/m^{2}since 2021). The main rainy periods of December were between 5-7.XII, 9-11.XII and 25-27.XII, and the highest daily average rainfall for the whole of Oltenia was 27.0 l/m^2 recorded on the 11th. The precipitationa in December 2021 were in the form of rain (except for the night of 29/30.XII.2021 - light) and restored the water supply in the soil which was deficient since summer. ***An insignificant snow layer*** (≤ 4 cm) was registered on a restricted area only on 30.XII.

1b. The thermal regime of January 2022.

The monthly averages of the air temperature were between -1.1°C at Voineasa (negative average) and ***3.4°C at Calafat, and their deviations from normal were between 2.9°C at Târgu Logreşti and 5.2°C in Calafat***. According to the Hellmann criterion, January 2022 was hot (C) in the whole of Oltenia except for the restricted area of Calafat where it was very hot (FC) (Table 3). ***The average monthly air temperature*** calculated for the entire Oltenia region was 1.5°C with a deviation from normal of 4.07°C, which shows that January was a warm (C) month on average for the whole region. ***The maximum monthly temperature values*** were recorded in the range 1-5.I and ranged from 12.0°C in Voineasa (on 1.I) to 18.1°C in Calafat (on 3.I), and their average calculated for the entire Oltenia region of 15.9°C. ***The minimum monthly air temperature values*** were recorded on 25.I and ranged from -16.3°C in Voineasa to -6.1°C in Calafat. ***The average monthly temperature*** for the whole region was -10.8°C. ***The heat units*** in January ranged from 28.1 in Voineasa to 116.8 in Calafat, and their average for the entire region was 72.6. ***The cold units*** ranged from 6.5 in Calafat to 62.0 in Voineasa, and ***their average for the entire region*** was 26.0. These were mainly in the range 12-14.I and 22-25.I and were mostly insignificant in most of the region.

The frost units (according to the ANM definition from 2022) were registered in the range 22-25.I and ranged from 0.6 in Slatina to 15.8 in Tg. Logreşti, and their average for the entire Oltenia region was 5.0, which means a ***mild winter month (low intensity frost) (IB) for the harshness of winter***.

Table 3. The air temperature regime in Oltenia and the minimum and maximum surface temperature values in January 2022 (NI = January norms calculated for the period 1901-1990, MI = monthly averages of January 2022; Δ = MN = temperature deviation, CH = Hellmann criterion).

Meteorological Station	Hm	NI	MI	Δ=M-N	CH	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
Dr. Tr .Severin	77	-1,1	3,2	4,3	C	16,1	3	-9,0	25	17,5	2	-10,6	26
Calafat	66	-1,8	**3,4**	**5,2**	FC	18,1	3	-6,1	25	20,1	30	-6,8	26
Bechet	65	-2,2	2,4	4,6	C	15,8	5	-8,2	25	13,6	4	-6,5	26
Baileşti	56	-2,3	2,1	4,4	C	15,0	3	-8,5	25	17,1	5	-7,3	26
Caracal	112	-2,9	1,9	4,8	C	16,0	5	-8,9	25	20,2	1	-6,4	26
Craiova	190	-2,6	1,7	4,3	C	16,0	5	-10,0	25	17,1	5	-11,9	25
Slatina	165	-2,4	1,7	4,1	C	16,2	1	-10,6	25	15,7	4	-12,7	26

[7] The meteorological stations Voineasa and Bâcleș, because in the cold season, they have incomplete rainfall data (the precipitation signal being kept covered), cannot be taken into account.

Bacleș	309	-3,0	1,2	4,2	C	15,6	5	-10,8	25				
Tg. Logrești	262	-2,7	0,2	***2,9***	C	15,6	3	-15,9	25	17,0	2	-13,2	25
Drăgășani	280	-2,2	2,1	4,3	C	17,3	1	-9,5	25	***11,3***	***1***	***-4,6***	***26***
Apa Neagră	250	-2,6	0,6	3,2	C	17,0	2	-12,0	25	13,7	2	-10,8	26
Tg. Jiu	210	-2,6	1,2	3,8	C	16,1	2	-12,4	25	17,4	2	-13,8	26
Polovragi	546	-3,2	0,0	3,2	C	15,2	3	-12,1	25	14,2	4	***-15,0***	***25***
Rm. Vâlcea	243	-2,2	1,6	3,8	C	16,5	2	-11,6	25	17,9	28	-14,9	25
Voineasa	587	-4,7	***-1,1***	3,6	C	***12,0***	***1***	***-16,3***	***25***				
Parâng	1585												
Average Oltenia	-	-2,6	1,5	4,07	C	15,9		-10,8		16,4		-10,3	
Ob. Lotrului	1404	-6,2	-5,3	0,9	N	7,9	5	-23,2	24				
Petroșani	-	-3,2				14,1	5	-22,8	25	12,3	2	-23,8	26

(Source: data processed from the ANM archive)

The graphs of the variation of the parameters that characterize the air temperature in January (daily averages, daily minima and daily maxima) have decreasing linear trends (Fig. 2). There were 3 warm-up intervals: 1-7.I (7 days), 14-20.I (7 days) and 26-31.I (6 days), totalling 20 days. Except for the mountain area (Parâng weather station), in just 2 days (12 and 13.I), the average air temperature calculated for the entire Oltenia region was negative. ***The highest daily average temperatures*** calculated for the entire Oltenia region were recorded at 1.I (14.5°C), 2.I (14.2°C), 3.I (14.8°C), 4.I (13.8°C) and 5.I (14.1°C).

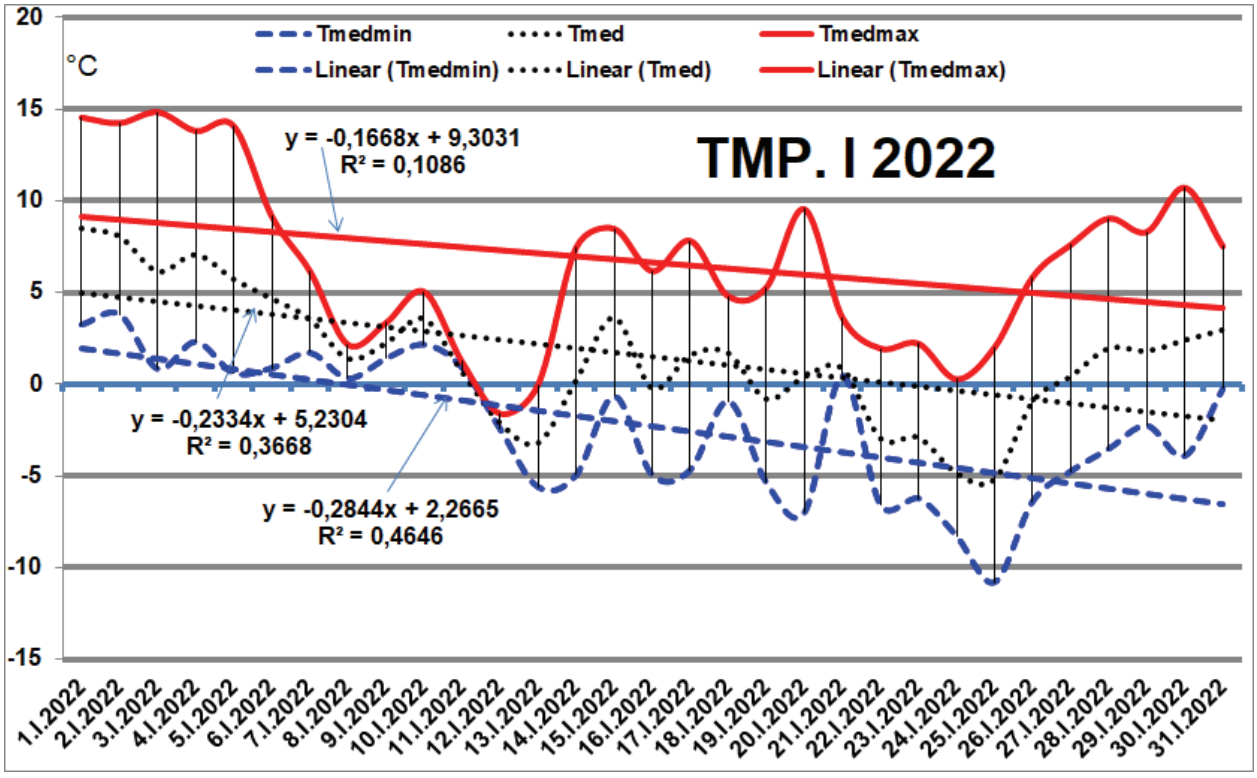

Figure 2. Variation of the parameters that characterize air temperature (average daily minimums, daily average and average daily maximums, calculated for the entire region) in January 2022. (Source: data processed from the ANM archive).

2.b. The rainfall regime of January 2022

The monthly precipitation amounts in January ranged from 12.5 l/m^2 in Craiova to 55.9 l/m^2 in Apa Neagră (Table 2). Their percentage deviations from normal ranged from -66.7% in Craiova to -24.7% in Dr. Tr. Severin, and according to the Hellmann criterion, January was dry (S) in the extreme west (Dr. Tr. Severin), in the area of the sub-Carpathian depressions (Apa Neagră, Tg. Jiu and Polovragi), very dry (FS) in the south of the Oltenia Plain (Calafat, Bechet and Băilești) and in the area of the hills at Tg. Logrești and Drăgășani, excessively dry (ES) in the Romanați Plain at Caracal, at the southern limit of the hills in Craiova, in the Getic Piedmont at Slatina, in the Mehedinți Hills at Bâcleș, in the Olt Corridor at Rm. Vâlcea and in the Intramountain Depression. The average monthly quantity calculated for the entire Oltenia region was 26.4 l/m^2, and its percentage deviation from normal was -39.9%, which according to the Hellmann criterion shows that January was very dry (FS) on average for the whole Oltenia region.

3.b. The thermal regime of February 2022.

The monthly averages of the air temperature ranged from 1.1°C at Voineasa to 5.4°C at Dr. Tr. Severin and Calafat, and their deviations from normal were between 3.6°C at Voineasa and 5.3°C in Drăgășani. According to Hellmann, February 2022 was hot (C) in most of Oltenia and very hot (FC) in small areas in the extreme southwest at

Calafat, in the Romanați Plain at Caracal, at the southern limit of the Oltenia Hills in Craiova, in the Mehedinți Hills in Bâcleș and in the Olt Corridor in Drăgășani (Table 4). The average monthly air temperature calculated for the entire Oltenia region was 3.97°C, and its deviation from normal was 4.43°C. According to Hellmann, February was a warm month (C) for the entire Oltenia region. ***February was thus the warmest month of the winter 2021-2022.***

Table 4. Oltenia air temperature regime and minimum and maximum surface temperature values in February 2022 (N II = February norms calculated for the period 1901-1990, M II = monthly averages of February 2022; Δ = M-N = temperature deviation, CH = Hellmann criterion).

Meteorological Station	Hm	NII	MII	Δ=M-N	CH	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
Dr. Tr .Severin	77	0,9	5,4	4,5	C	17,4	11	-4,2	4	20,0	11	-5,0	5
Calafat	66	0,4	5,4	5,0	FC	18,4	11	-5,0	4	28,5	19	-4,7	6
Bechet	65	-0,1	4,4	4,5	C	17,8	11	-7,3	4	20,1	21	-4,1	4
Băilești	56	-0,1	4,3	4,4	C	17,4	11	-6,9	4	26,3	19	-5,5	4
Caracal	112	-0,7	4,4	5,1	FC	17,2	19	-7,4	4	22,0	25	-4,9	25
Craiova	190	-0,4	4,6	5,0	FC	16,8	19	-6,0	4	19,6	19	-7,6	5
Slatina	165	-0,2	4,1	4,3	C	17,0	11	-7,6	4	20,1	21	-9,1	4; 5
Bâcleș	309	-0,9	4,2	5,1	FC	16,1	11	-5,2	4				
Tg. Logrești	262	-0,7	2,6	3,3	C	16,4	11	*-10,0*	*4*	25,2	19	-10,2	4
Drăgășani	280	-0,2	5,1	5,3	FC	17,1	11	*-4,1*	*4*	*13,9*	*19*	*-2,2*	24
Apa Neagră	250	-0,6	2,8	3,4	C	17,3	11	-8,4	4	19,0	19	-6,1	7
Tg. Jiu	210	-0,4	4	4,4	C	16,9	11	-5,7	5	19,5	19	*-11,3*	5
Polovragi	546	-1,4	2,8	4,2	C	14,7	11	-6,1	5	21,4	23	-9,4	4
Rm. Vâlcea	243	0,0	4,3	4,3	C	16,1	11	-5,2	4	27,9	19	-9,3	6
Voineasa	587	-2,5	*1,1*	3,6	C	*13,7*	*11*	-7,2	4				
Parâng	1585	-											
Average Oltenia	-	-0,46	3,97	4,43	C	16,7		-6,42		21,8		-6,9	
Ob. Lotrului	1404	-5,5	-3,5	2	C	10,1	17	-15,2	4				
Petroșani	-	-1,3				14,4	19	-11,2	4	11,0	17	-11,6	4

(Source: data processed from the ANM archive)

The lowest monthly air temperature was recorded mostly on 4.II and ranged from -10.0°C at Tg Logrești to -4.1°C at Drăgășani, and the average for the whole region was of -6.42°C. The daily averages of the minimum temperatures for the whole region were negative in the intervals: 1-7.II, 9-11.II, 14-15.II, 19, 21, 24-25.II, totalling 16 days and in 12 days they were positive.

The maximum monthly air temperatures were recorded on 11.II and were between 13.7°C in Voineasa and 18.4 in Calafat, and their average for the whole region was 16.7°C, being the highest in winter. For the thermal maximums in the air, two growth intervals were registered: 1-12.II and 15-25.II totalling 23 days.

The heat units in February were between 40 in Voineasa and 151.7 in Dr. Tr. Severin and Calafat, and the average for the whole region was 112.9, being the highest throughout the winter. The cold units were insignificant and ranged from 0 in Dr. Tr. Severin, Calafat, Craiova, Drăgășani and Rm. Vâlcea and 8.7 in Voineasa, and their average for the entire region was 1.6. So, according to the balance of heat and cold units, February was a warm month.

The graphs of the variation of the parameters that characterize the air temperature in February (daily averages, daily lows and daily highs) have increasing linear trends (Fig. 3).

At the surface of the soil, the monthly thermal minimums were recorded in the data of 4, 5, 6, 24 and 25.II and were between -11.3°C at Tg. Jiu on 5.II and -2.2°C in Drăgășani on 24.II, and their average for the entire region was -6.9°C. 22 days later, the average daily minimum surface area was negative. ***The daily maximum temperatures*** at the soil surface were recorded on 11, 19, 21, 23 and 25.II and were between 13.9°C in Drăgășani and 28.5°C in Calafat, and their average for the whole region was 21.9°C. On all days, the average daily high for the entire region was positive and ranged from 5.0°C on 7.II to 21.2 on 19.II. Therefore, in 22 days, there were ***alternating frosts and thaws on the soil surface,*** causing the plants to be barefoot in the autumn crops, and in 6 days the soil remained thawed.

3b. The rainfall regime of February 2022

The monthly precipitation amounts ranged from 6.8 l/m^2 in Caracal to 23.2 l/m^2 in Apa Neagră, and their percentage deviations from normal were between -80.5% in Calafat and -41, 5% in Drăgășani (Table 2). According to the Hellmann criterion, February 2022 was excessively dry (ES) in most of Oltenia. The average monthly rainfall for the entire region was 13.7 l/m^2, and its percentage deviation from normal was -67.7%, which shows that on average February was excessively dry (ES).

4. Seasonal climatic characteristics of winter 2021-2022

The seasonal averages of the air temperature were between 0.3°C at Voineasa and 4.2°C at Calafat, and their deviations from normal were between 2.6°C at Tg. Logrești and 4.3°C in Calafat.

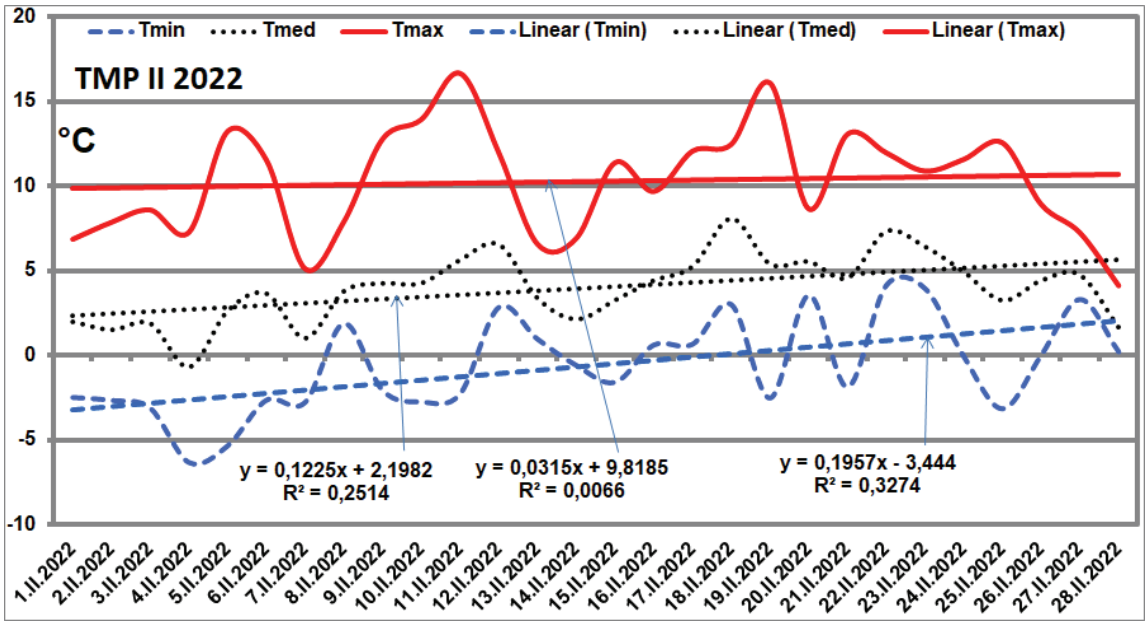

Figure 3. The variation of parameters that characterize air temperature (average daily lows, daily average and average daily highs, calculated for the entire region) in February 2022 (Source: data processed from the ANM archive).

According to the Hellmann criterion[8], the winter 2021-2022 was very hot (FC) (Table 5). ***The seasonal average air temperature*** for the entire Oltenia region was 2.61°C, which confirms that on average the winter 2021-2022 was very hot (FC) for the entire Oltenia region.

The winter 2021-2022 was the 4th warmest winter, in decreasing order of seasonal averages of temperature after the following: 2006-2007 with an average season of 3.44°C, winter 2015-2016 with an average of 2.88°C and 2019-2020 with an average of 2.80°C. In the history of Oltenia's climate, ***only four Mediterranean winters*** have been recorded so far: ***2006-2007 with an annual average of 3.44°C, 2019-2020 with an average of 2.80°C, 2021-2022 with an average of 2.61°C and 2020-2021 with an average of 2.55°C***, the winter of 2021-2022 being the third Mediterranean winter[9] in descending order of the seasonal temperature average. ***The seasonal amounts of precipitation*** were between 83.8 l/m^2 at Bechet and 249.3 l/m^2 at Apa Neagră, and their percentage deviations from normal values were between -26.0 at Polovragi and 89.5 % at Bâcleș. According to the Hellmann criterion, the winter 2021-2022 was very dry (FS) in the mountain area of Parâng, dry (S) at Tg. Logrești, Drăgășani and Polovragi, slightly dry (PS) at Apa Neagră and Rm. Vâlcea, normally pluviometric at Dr. Tr. Severin, Slatina and Tg. Jiu, rainy (P) in Bechet, Caracal and Craiova, very rainy (FP) in Calafat and Băilești and exceptionally rainy (EP) in Voineasa and Bâcleș.

Table 5. The overall rainfall and thermal regime of winter 2021-2022. Hm = weather station altitude, W`20-`21 = average winter temperature values 2021-2022 (°C), NW = normal values of winter temperature averages in winter (°C), Δ = WN = average temperature deviations than normal (°C) CrH = Hellmann criterion, SW = sum of precipitation in winter 2021-2022 (l/m^2), NW = normal values of precipitation in winter (l/m^2), Δ = SN = deviations of seasonal quantities from normal (l/m^2), Δ% = percentage deviations from normal).

No.	Meteorological Station	Hm	Thermal regime (°C)				Pluviometric regime (l/m^2)				
			W`21-`22	NW	Δ=W-N	CrH	SW	NW	Δ=S-N	Δ%	CrH
1	Dr. Tr. Severin	77	4,1	0,4	3,7	FC	157,7	160,5	2,8	1,8	N
2	Calafat	66	4,2	-0,1	4,3	FC	95,6	123,9	28,3	29,6	FP
3	Bechet	65	3,3	-0,6	3,9	FC	83,8	104,6	20,8	24,8	P
4	Băileşti	56	3,1	-0,7	3,8	FC	90,7	121,4	30,7	33,8	FP
5	Caracal	112	3,0	-1,2	4,2	FC	85,6	108,7	23,1	27,0	P
6	Craiova	190	2,9	-1,0	3,9	FC	86,8	109,7	22,9	26,4	P
7	Slatina	165	2,8	-0,8	3,6	FC	109,8	117,2	7,4	6,7	N
8	Bâcleș	309	2,5	-1,4	3,9	FC	78,8	149,3	70,5	89,5	EP
9	Tg. Logrești	262	1,5	-1,1	2,6	FC	159,7	121,7	-38.0,	-23,8	S
10	Drăgășani	280	3,3	-0,6	3,9	FC	144,7	114,1	-30,6	-21,1	S
11	Apa Neagră	250	1,8	-1,0	2,8	FC	249,3	219,6	-29,7	-11,9	PS
12	Tg. Jiu	210	2,4	-1,0	3,4	FC	175,8	169,9	-5,9	-3,4	N
13	Polovragi	546	1,4	-1,5	2,9	FC	207,4	153,4	-54,0	-26,0	S

[8] Hellmann criterion for *seasonal and annual averages of air temperature*: Δt≤-5.0°C = >excessive cold (ER); -4.9 ≤Δt≤ -2.6°C = >very cold (FR); -2.5 ≤Δ -1.1°C = (cool (R); -1.0≤Δt≤-0.6°C = >cool (RC); -0.5≤Δt≤ + 0.5°C = >normal (N); 0.6 ≤Δ 1.0°C = >heat (CL); 1.1≤Δt≤ 2.5°C = >heat (C); 2.6 ≤Δ 4.9°C = > very hot (FC); Δt≥5.0°C = > excessive heat (EC).

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

14	Rm. Vâlcea	243	2,8	-0,6	3,4	FC	143,7	120,1	-23,6	-16,4	PS
15	Voineasa	573	*0,3*	-3,0	3,3	FC	79,5	141,8	62,3	78,4	EP
16	Parâng	1585					235,2	160,0	-75,2	*-32,0*	FS
	Avegare Oltenia	-	2,61	-0,95	3,56	FC	136,5	137,2	0,7	0,5	N
17	Ob. Lotrului	1348	-3,8	-5,5	1,7	C	271,8				
18	Petroșani	607		-1,7			157,1	139,5	-17,6	-11,2	PS

(Source: data processed from the ANM archive)

The average of the seasonal quantities for the entire Oltenia region was 136.5 l/m^2, and its percentage deviation from normal was 0.5%, which according to the Hellmann criterion shows that the winter 2021-2022 was normal rainfall (N).

DISCUTIONS

Throughout the winter, there were ***eight warm-up intervals***: 1-3.XII.2021 (3 days), 24-26.XII.2021 (3 days), 31.XII (1 day); 1-7.I.2022 (7 days), 14-20.I (7 days), 26-31.I.2022 (6 days), 1-12.II (12 days), 15-26.II (12 days), totalling 51 days (56.7% of winter days).

For the entire winter season, ***the heat units*** ranged from 111.5 in Voineasa to 392.4 in Calafat, and their average for the entire Oltenia region was 270.7. ***The cold units*** were between 9.3 in Calafat in the extreme southwest and 90.9 in the Voineasa intramountain depression, and their average for the entire Oltenia region was 38.9. ***The frost units*** were registered in the Getic Piedmont, the area of the hills and the mountain area, being between 0.6 in Slatina and 19.8 in Tg. Logrești, and their average for the entire Oltenia region was 6.5, i.e. the winter of 2021-2022 was ***a mild winter in terms of agrometeorology. The seasonal thermal extremes were***: the maximum thermal season of 18.4°C registered in Calafat on 11.II.2022 (only 0.3°C higher than the thermal maximum of January), and the minimum thermal season of - 16.3°C at Voineasa on 25.I.2022.

The increase in the frequency of Mediterranean winters is a confirmation of the northward expansion of the Mediterranean climate due to global warming. Warm winters are a particular climatic risk and have almost always been followed by cold March months with late winter phenomena, cold waves, snow, frost, ground frost. The warming of the winter weather determines the development of the vegetation, and the late winter phenomena capture the vegetation in advanced stages of development and produce significant damage. Thus, in some years, the crops of almonds, apricots and peaches and even plums are destroyed. Even vegetable crops in unheated solariums are sometimes affected and destroyed. ***The causes of the intense cooling of March*** are due to the cooling of the air in the polar zone which reaches its maximum intensity in March before the spring equinox (at the end of the polar night), and the slowing of the speed of air movement in the Polar Vortex and the production of cold waves. In the Mediterranean winter 2021-2022, the crops had many periods in which they started growing and continued to develop. Phenological observations showed that: on 10.II.2022 the hazelnut blossomed, on 25.II.2022 the white magnolia blossomed, on 1.III.2022 the willow blossomed and the almond began to bloom on 8.III.2022. On March 18, 2022, the wax cherry bloomed. Between 6-13.III.2022 there was a cold wave in Eastern and SE Europe. On the night of 10 / 11.III.2022 it snowed and a layer of snow formed in many areas of Oltenia. In some communes in Mehedinți County, the thickness of the snow layer reached 15 cm, when the apricot trees had started to bloom (Romania TV 12.III.2022). As a result of the increase in the frequency of warm winters in Mehedinți County, fig crops developed on large areas and began to appear in the warmest county of Oltenia - Dolj. We will further analyse the synoptic causes of the most intense cooling of the weather this winter recorded on 25.I. 2022 and the most intense heating produced on 11.II. 2022.

The synoptic causes that determined the cooling of the weather on 25.I 2022. The initiation of the advancement of the cold air mass cPk over Europe took place on 20.I.2022. On the 24th, the extremely cold air core separated over South-Eastern Europe, and in Oltenia the maximum cooling intensity was recorded on the morning of the 25th. On 27.I.2022, the cold air mass retreated from the south of Romania.

On 25.I.2022 at 00 UTC, ***at the level of the earth's surface***, the distribution of the main baric centres was as follows: a vast anticyclone belt extending from the Atlantic Ocean to the Eastern European Plain, dominates most of Europe. In our country and south of this vast anticyclone field, there were cyclonic fields (Fig. 4). The strongly developed Azoric anticyclone with centre values of over 1035 hPa as the Eastern European one in the Eastern European Plain. Deep Icelandic cyclone with centre values below 945 hPa. Above the Black Sea and in the south-eastern Mediterranean a vast weak cyclonic field with values at the center just below 1020 hPa. In this synoptic context, an atmospheric blocking circulation developed over Europe (the 552 damgp isohypsis has the approximate shape of the letter Ω). For Oltenia and Romania the air circulation was from the northeast and north with a particularly cold continental and cold Arctic air mass (cPk + A).

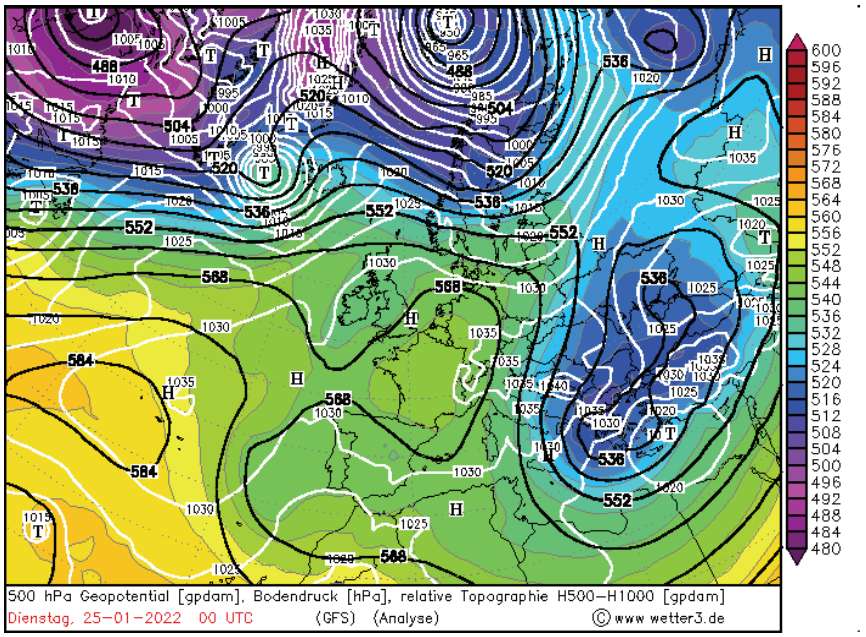

Figure 4. The synoptic situation at the level of the earth's surface (atmospheric pressure field) overlapping with the synoptic situation from altitude (geopotential field at 500 hPa - about 5000 m altitude) and relative baric topography field (TR 500/1000) from 25.I.2022 at 00 UTC. (***. www.wetterr3.de).

In the lower troposphere, at 500 hPa (about 5000 m altitude), the geopotential field had high values above the Atlantic Ocean (584 damgp), a low gepotential nucleus stands out above the Black Sea and the eastern Mediterranean with values at the center below 538 damgp, and above the area of Iceland very low values below 480 damgp. At the level of 850 hPa (about 1500 m) it is observed the separation of the extremely cold air mass over Romania, the Black Sea and the eastern Mediterranean Sea with temperature values below -12°C. In this synoptic context, in an anticyclonic field, with clear skies and a duration of the night of 14 hours and 26 minutes, the cooling of the air near the earth's surface continued, and the minimum temperature in the morning of 25.I.2022 was between -16, 3°C at Voineasa and -6.1°C at Calafat, and in the mountain area there were -23.2°C at Ob. Lotrului and -16.9°C at Parâng. At the level of the earth's surface on 11.II.2022 the distribution of baric centres over Europe was as follows.

The Azoric anticyclone with values over 1030 hPa at the centre, was extended over the Atlantic Ocean to the UK and joined over southern Europe, through the anticyclone belt, with the Eastern European with values at the centre of over 1040 hPa (Fig. 5). North of this anticyclone field, the field of Icelandic cyclones with values at the centre below 980 hP was present. In the lower troposphere at 500 hPa (about 5000 m altitude), the southern half of Europe was dominated by a vast high geopotential field with two high geopotential nuclei of over 594 damgp over the Atlantic Ocean and one of 568 damgp in North Africa.

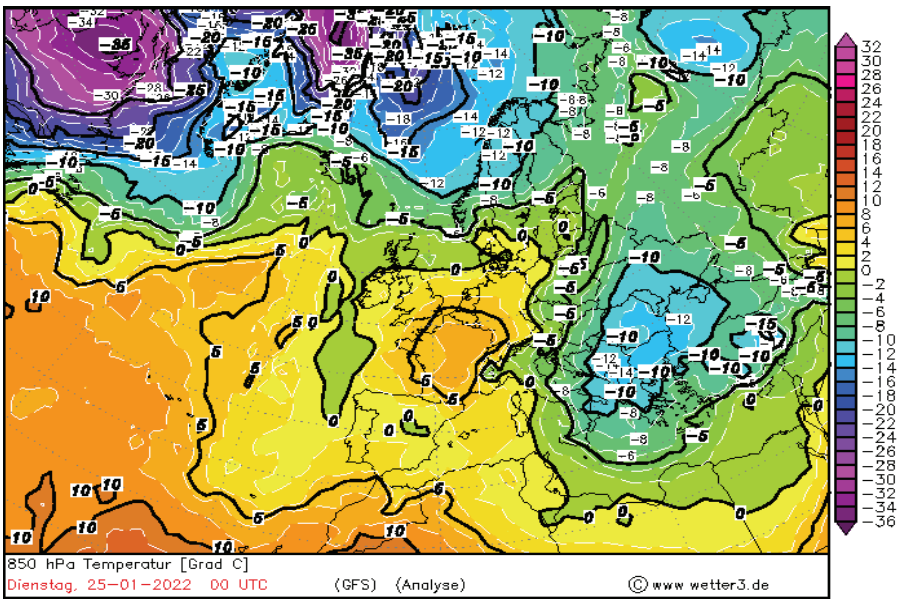

Figure 5. Temperature field at the level of the geopotential surface at the level of 850 hPa - about 1500 m altitude from 25.I.2022 at 00 UTC. (***. www.wetterr3.de).

The synoptic causes that determined the warming of the weather on 11.II 2022. The tropical hot air mass (T) started to travel over Europe on 1.II.2022, starting from western and southwestern Europe and progressed gradually occupying more than half of southern Europe (Fig. 6).

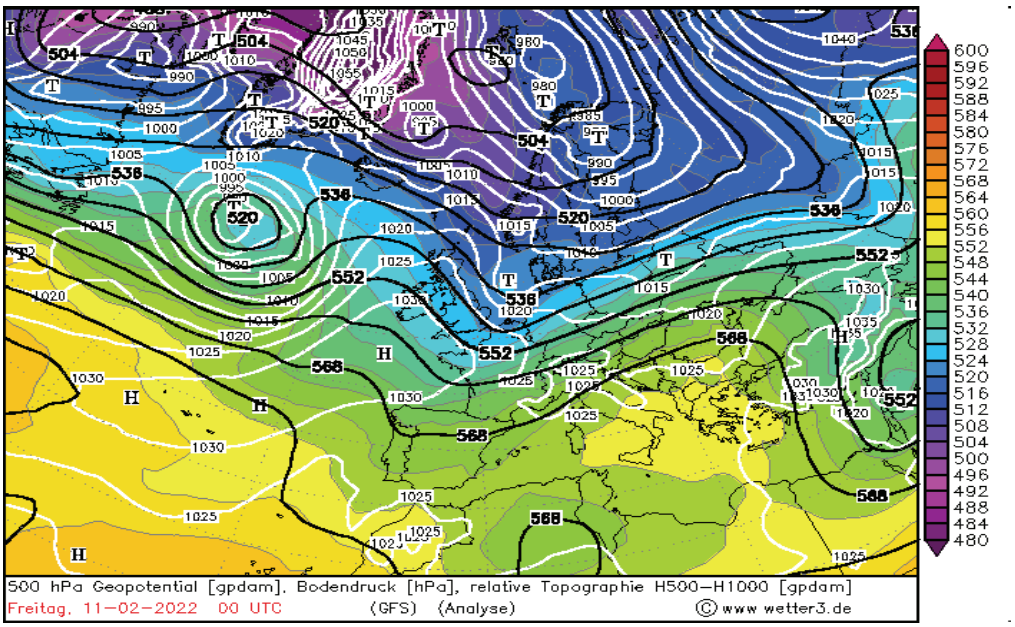

Figure 6. The synoptic situation at the level of the earth's surface (atmospheric pressure field) superimposed with the synoptic situation at altitude (geopotential field at 500 hPa - about 5000 m altitude) and the field of relative baric topography (TR 500/1000) from 11.II.2022 at 00 UTC. (***. www.wetterr3.de).

In this synoptic context, the air circulation over Oltenia and Romania was south-western, bringing a tropical hot air mass (T) over southern Europe. This is confirmed by the advection of hot air over Europe at 850 hPa (about 5000 m altitude) (Fig. 7). The 5°C isotherm encloses almost all of southern Europe, and the south of Oltenia was a warm air core with values ≥6.0°C.

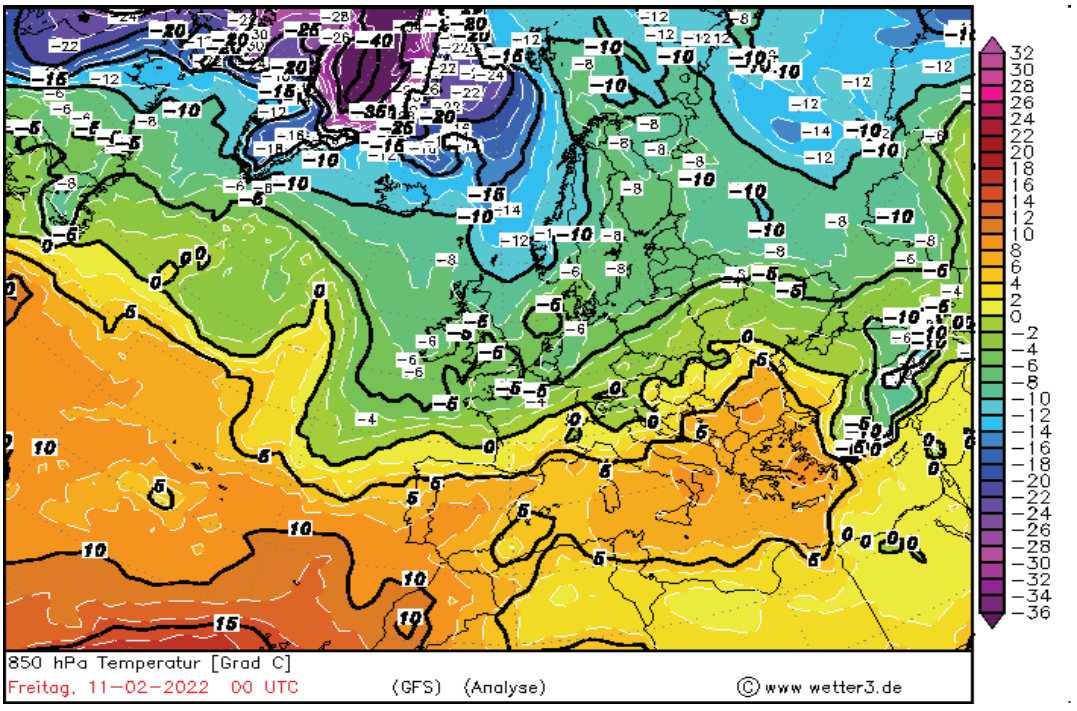

Figure 7. Temperature field at the level of the geopotential surface at the level of 850 hPa - about 1500 m altitude from 11.II.2022 at 00 UTC. (***. www.wetterr3.de).

CONCLUSIONS

The winter of 2021-2022 was ***a very warm winter*** (FC) with an average of 2.61°C and a deviation from the normal of 3.56°C, which means ***the fourth warmest winter in the history of meteorological observations***, after the winters of 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, 2015-2016 with average of 2.88°C and deviation of 3.83°C.

The winter of 2021-2022 surpassed the winter of 2020-2021 which had an average of 2.55°C and a deviation of 3.5°C, thus being the third Mediterranean winter in descending order of the seasonal average temperatures after the winters of 2006-2007 and 2019 -2020.

We note the gradual northward expansion of the Mediterranean climate and the increase in the frequency of warm and very warm winters, 18.0% of which were recorded since the winter of 2006-2007 and the last three winters were very hot (FC) (2019-2020, 2020-2021, 2021-2022).

So far, no winter has been overly warm (EC) within the meaning of the Hellmann criterion, which does not justify the alarming presentation of climate warming forecasts. The last decade (2012-2022) was the warmest for the winter season and there were 5 warm winters (C) and 4 very warm winters (FC) (90% mild and very warm winters).

The winter 2021-2022 had, on average, normal rainfall (N), but large quantitative differences between different areas of Oltenia from very dry (FS) in the mountainous area to excessively rainy (EP) in Bâcleș and Voineasa. The snow layer was insignificant on small areas and with an ephemeral duration of several hours (30.XII.2021). December 2021 was the wettest of the whole winter season, with an average for the whole of Oltenia of 96.5 l/m^2 and the second wettest of 2021 after January 2021 and restored the water supply from the soil, after the summer very drought (FS) 2021.

The very hot winter (FC) 2021-2022 was a good counterexample for the statement that "if the pollution of the atmosphere decreases, the climate will cool down and return to normal". Under the conditions imposed by the covid pandemic 19 (declared closed on 9.III.2022), air pollution decreased, but the global warming also continued after the hot summer (C) 2021 followed by the very hot winter (FC) 2021- 2022. The long periods of warming and cooling of the climate are mainly due to the oscillations of the tilt of the earth's axis and other factors of a cosmic nature.

REFERENCES

BOGDAN OCTAVIA, MARINICĂ I., RUSAN N., RUSU SIMONA. 2007. Riscul iernilor calde în România (cu aplicaţii la iarna 2006-2007). *Riscuri şi Catastrofe, Editor Victor Sorocovschi An VI*. Edit. Casa Cărţii de Ştiinţă. Cluj Napoca. **4**: 97-110.

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).

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.

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

***. http://stiri.tvr.ro/anul-2021-a-fost-unul-dintre-cei-mai-caldurosi-ani-din-istoria-masuratorilor meteorologice_898194.html#view (accessed February 10, 2022).

***. http://ro.wikipedia.org/wiki/Biocenoz%C4%83 (accessed February 2022).

***. www.wetterr3.de (accessed February 2022).

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

Diaconu Luminița
Theoretic High School "C-tin Brâncoveanu", Dăbuleni, Dolj, Romania.
E-mail: diaconu_luminita_vip@yahoo.com

Received: March 31, 2022
Accepted: June 07, 2022