

CLIMATE VARIABILITY IN SPRING 2019 IN SOUTH-WEST ROMANIA

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Abstract: In 2019, the solar activity reached a minimum, the El Niño phenomenon was absent, carbon dioxide concentrations exceeded 410 ppm (the highest level in the last 120,000 years), and climate warming continued. As a result, in southwestern Romania (and not only), the climatic evolutions were marked by a great variability. The warming of the weather started from 14.I.2019 and culminated with the warm March. On 18.III in Romania, the European climatic record of the hottest day of March 18 in the last 120 years was recorded. The precipitations were deficient for extended periods of time, March being excessively dry, and April even on average rainfall, but in areas extended especially in the Oltenia Plain and in the hills area, the drought persisted. The strong instability of the weather that started on 20.IV.2019 and culminated with torrential rains that caused flooding in some areas, abundant hail and tornadoes between 30.V-6.VI, which brought a completion of water supply. The recording of the first moderate heat wave in the period 10-16.VI has restored the drought problem. The paper analyzes the climate variability of spring 2019 and its synoptic causes.

Key-words: early coming of spring, drought, late spring cooling, late spring haze, instability, tornado.

1. INTRODUCTION

Although El Niño was absent and the Sun was at the minimum of its activity, which was reached in 19.V.2019, the date after which, for several consecutive weeks, the surface of the star in that day remained without any sunspot (<https://metro.co.uk/2019/06/04/sun-reached-solar-minimum-surface-ominously-calm-9805282/>), and the climate warming continued. During the minimum period of solar activity, the number of sunspots is significantly lower and its magnetic field weakens, allowing cosmic radiation outside our solar system to fall on Earth. Thus, *the US National Oceanic and Atmospheric Administration (NOAA) announced that 2018 is the **fourth** hottest year to date, continuing the string of climate change records that have been unprecedented for at least 11,000 years* (<https://www.green-report.ro/2018-al-patrulea-cel-mai-calduros-an-inregistrat-vreodata/>). The year

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2018 will replace 2014 as the fourth hottest year, which means that the last five years (2014-2018) have been the hottest in modern human history. The summer temperatures of the last years have been the highest recorded on the planet in the last 120.000 years. Concentrations of carbon dioxide in the air, which exceeded 410 ppm for a full month in 2018 (April 2018 - <https://www.green-report.ro/co2-aprilie-record/>), are now higher than ever in the last 15 million years. *NOAA analysis* shows that 2018 was the fourth hottest year, the January-November anomaly being 0.77°C, compared to the 20th century average, between 2017 (+ 0.85°C) and 2014 (+ 0.74°C). *In Romania*, the average annual air temperature in 2018 was 11.57°C, being the third highest value from 1901 to date, according to records from weather stations with a long range of observations (ANM). The average air temperature in 2018 exceeded by 1.35°C the climatological average for the period 1981-2010 (according to the Deputy Prime Minister and Minister of the Environment, Grațîela Gavrilescu - <http://www.meteoromania.ro/>). In Oltenia the average annual temperature in 2018 calculated for the whole region was 11.76°C, and the deviation from the general average of the last century was 1.94°C, which shows that at the regional level, Oltenia was one of the hottest areas of Romania. In this context, the climate variability during the year 2018 in Oltenia was very high. This way of manifestation of weather-climatic phenomena continued in winter 2018-2019 and in spring 2019. We continue to analyze this particularly high climate variability from spring 2019 in Oltenia. The paper is part of an extensive series of studies on climate change and climate variability in southwestern Romania (Bogdan, Niculescu 1999, Bogdan, Marinică, Andreea Floriana Marinică 2010, Marinică, Andreea Floriana Marinică 2016).

2. MATERIAL AND METHOD

For the accomplishment of the work we used the results of the daily processing, with special software from the weather forecasting process, the data archive of the ANM¹, the maps made currently in the operational activity, those on the Internet provided by the international analysis and forecasting centers and those from ANM Bucharest. I used the facilities offered by Microsoft Office for drawing tables and graphs. The paper analyzes the climate variability from spring 2019 in southwestern Romania, based on the thermal and rainfall regime of March, April and May 2019 and the overall thermal and rainfall regime of spring 2019.

3. RESULTS AND DISCUSSIONS

1a. Thermal regime of March 2019

The monthly averages of the air temperature were between 5.1°C in Voineasa at the limit between the mountain area and the low altitude area and 10.4°C in Calafat in the extreme southwest of Oltenia, and their deviations from the normal values were between 2.7°C at Voineasa and 5.1°C at Drăgășani, which

¹ ANM = National Meteorological Administration

is in the warm-weather type (C) at all weather stations except for a restricted area at Drăgășani where it was very warm (FC) (Table 1). The average monthly air temperature calculated for the entire Oltenia region was 8.6°C, and its deviation from the normal was 4.0°C, which confirms that March was warm (C) for the entire region. **The 4.0°C deviation of March is the largest positive deviation from the normal for the first five months of 2019**, which shows that **in March there was the greatest warming of the weather**. The monthly average temperature increase from February to March was 5.9°C ($\Delta T = \text{III-II} = 8.6-2.7 = 5.9^\circ\text{C}$), ie a higher increase of 0.9°C compared to the normal increase of 5.0°C. January 2019 was warmish, and February 2019 warm, which shows a long compact coming of spring period in the 2018-2019 cold season. All this largely explains the **early coming of spring of 2019**, which after the average coming of spring index of 467.6, was **the 6th earliest coming of spring, in the decreasing order of the coming of spring index** (I-2016 = 543.3; I-2002 = 525.7; I-2007 = 498; I-2008 = 479.7; I-2013 = 475.3; I-2019 = 467.6). **For the period 1998-2019, there was only one late coming of spring in 2003, with the average index of 181.5, all the others being early which shows the extent of the climatic heating in the southwest of Romania**. The monthly air temperature minima were recorded differentially on the relief steps as follows: in the plain area on the date of 4.III, and in the hill area on the dates of 13 (most) and 15.III and were between -7.8°C at Apa Neagră (Padeș on 13.III) and -1.2°C at Calafat and Caracal (on 4.III), and their average for the whole region was -3.5°C. In 25 days (80.6% of the days of the month), the daily average of the air temperature calculated for the entire region (area with an altitude ≤ 600 m) was positive.

There were **fogs and frosts in the air** of local or isolated character in just 6 mornings. The vegetation started early development and from 2.III the white magnolia bloomed (one of the plants with the earliest flowering - a true indicator of the coming of spring), and by the end of the month, all the species of fruit trees had the fruits formed.

Table 1. The air temperature regime in Oltenia and the minimum and maximum temperature values at the ground surface in March 2019, for the area with altitude ≤ 600 m (N = normal in March, for the period 1901-1990; M'19 = temperature averages in March 2019; $\Delta = M-N$ = temperature deviation; CH = Hellmann Criterion: C=warm, FC=very warm).

(Source: data processed from the ANM archive)

Meteorological station	Hm	N	M'19	$\Delta=M-N$	CH	Tmin air		Tmax air		Tmin soil		Tmax soil	
						(°C)	Date	(°C)	D	(°C)	Date	(°C)	Date
Dr. Tr. Severin	77	5.9	10.1	4.2	C	-1.4	13	25.9	17	-3.0	13;1	45.2	31
Calafat	66	5.6	10.4	4.8	C	-1.2	4	25.8	8	-0.1	15	34.9	31
Bechet	65	5.4	9.1	3.7	C	-3.6	4	25.4	18	-1.2	4;29	34.8	18
Băilești	56	5.4	9.3	3.9	C	-2.7	4	25.3	17	-4.4	4	31.9	18
Caracal	112	4.9	9.4	4.5	C	-1.2	4	24.8	18	0.4	1	26.0	18
Craiova	190	5.1	9.4	4.3	C	-1.4	15	24.7	18	-2.4	4	42.0	31
Slatina	165	5.0	9.1	4.1	C	-3.6	4	24.5	18	-1.6	4	23.3	25;31
Băcleș	309	4.5	8.8	4.3	C	-1.6	13	22.7	18	-	-	-	-
Tg. Logrești	262	3.6	6.7	3.1	C	-5.6	15	23.6	18	-6.4	29	39.5	31

Drăgășani	280	4.7	9.8	5.1	FC	-1.8	4	23.5	18	-0.5	13;15	23.7	31
Apa Neagră	250	4.2	7.5	3.3	C	-7.8	13	23.5	17	-2.7	13	23.8	31
Tg. Jiu	210	4.8	8.7	3.9	C	-3.5	15	24.2	18	-3.4	15;28	39.8	31
Polovragi	546	3.0	7.3	4.3	C	-3.8	15	20.9	18	-6.9	13;28	36.8	31
Rm. Vâlcea	243	5.0	8.5	3.5	C	-2.7	13	24.3	18	-4.0	4	36.0	31
Voineasa	587	2.4	5.1	2.7	C	-6.1	13	21.7	18	-	-	-	-
Parâng	1585	-	-	-	-	-7.5	13	12.8	17	-	-	-	-
Average Oltenia	-	4.6	8.6	4.0	C	-3.5		23.4	-	-2.8	-	23.5	-
Ob. Lotrului	1404	-2.4	-0.3	2.1	C	-13.8	13	13.6	31	-	-	-	-

The monthly maximums of air temperature were mostly recorded on 18.III and ranged between 21.7°C in Voineasa on 18.III and 25.9°C on Dr. Tr. Severin on 17.III, and their average for the whole region was 23.4°C. Thus were recorded summer days in the Oltenia Plain.

18.III was the **hottest day of March 18 in the last hundred years** and most daily records were recorded: 27.5°C in Călărași, 27.1°C in Giurgiu, 26.9°C in Oltenița, 26.2°C at Urziceni, 26.0°C at Zimnicea, 25.8°C at Calafat, Grivița and Filaret, 25.5°C at Titu, 25.4°C at Bechet and Băneasa, 25.3°C at Alexandria, 25.1°C at Afumați, Videle and Fetești, 25.0°C at Băilești (15 weather stations with $t_{max} \geq 25.0^\circ\text{C}$), 24.9°C at Buzău, 24.8°C at Caracal, 24.7°C at Craiova. This climate record was also recorded compared to the climate data recorded throughout the continent of Europe. **Thus, Romania holds the climatic record of the hottest day of 18.III on the whole continent of Europe.** It was recorded while a cold front affected Western Europe, and in the Southeast was the warmest part of the continent (tropical air circulation). As a result of the warm weather in March, the contribution of the temperatures recorded in March to the average index of discharge was 57.2%. **The minimum temperatures at the level of the soil surface** were recorded in the data of 1, 4, 13, 14, 15, 28 and 29 and were between -6.9°C in Plovragi and 0.4°C in Caracal, and their average for the whole region was -2.8°C. **The maximum temperatures at the soil surface** were recorded in the data of 18, 25 and 31.III and were between 23.1°C in Drăgășani and 45.2°C at Dr. Tr. Severin, and their average for the entire region was 23.5°C.

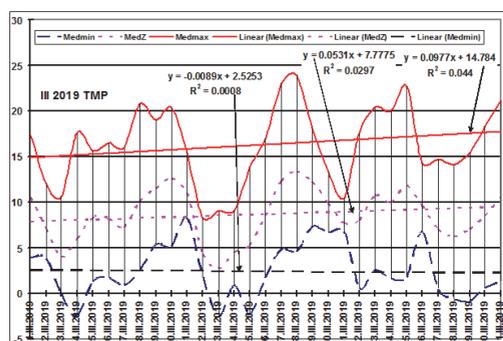


Fig. 1. Variation of the parameters that characterize the air temperature (average of the daily minima, daily averages and average of the daily maxima) in March 2019. (Source: data processed from the ANM archive).

The graphs of the parameters that characterize the air temperature in March (average of the daily minima, daily averages and average of the daily maxima), had

significantly increasing trends for the daily averages and the daily maximums and not significantly decreasing for the average of the daily minimums (Fig. 1).

1b. The rainfall regime for March 2019

The monthly amounts of rainfall recorded in March were between 1.0 l/m² at Dr. Tr Severin and 23.0 l/m² at Craiova, and their percentage deviations from the normal were between -98.0% at Dr. Tr Severin and -27.0% in Craiova, falling in the type class of rainfall time from excessively dry (ES) in most of Oltenia and dry (S) on a restricted area in Craiova (Table 2). The average of precipitation amounts calculated for the whole Oltenia region was 15.2 l/m², and the percentage deviation from this compared to normal was -63.8%, which shows that in March the average was excessively dry for the entire Oltenia region.

Table 2. Precipitation quantities (Σ (l/m²) recorded in spring 2019, compared to normal values (N); $\Delta\%$ = percentage deviation from normal; CH = Hellmann's Criterion:

ES=excessively droughty, FS=very droughty, S=droughty, N= normal.

(Source: data processed from the ANM Archive)

Meteorological station	Hm	March 2019				April 2019				May 2019			
		Σ	N	$\Delta\%$	CH	Σ	N	$\Delta\%$	CH	Σ	N	$\Delta\%$	CH
Dr. Tr. Severin													
Calafat	77	1.0	49.3	-98.0	ES	101.6	56.5	79.8	EP	73.0	80.7	-9.5	N
Bechet	66	12.2	38.1	-68.0	ES	47.8	47.3	1.1	N	108.4	60.8	78.3	EP
Băilești	65	18.8	36.3	-48.2	FS	44.6	48.6	-8.2	N	37.2	58.6	-36.5	FS
Caracal	56	16.7	38.3	-56.4	ES	45.9	49.4	-7.1	N	37.6	70.1	-46.4	FS
Craiova	112	20.0	35.7	-44.0	FS	40.4	45.1	-10.4	PS	76.0	61.4	23.8	P
Slatina	190	23.0	31.5	-27.0	S	44.4	43.1	3.0	N	45.2	60.6	-25.4	S
Băceș	165	21.4	37.5	-42.9	FS	27.4	47.4	-42.2	FS	52.8	64.8	-18.5	PS
Tg. Logrești	309	5.7	43.1	-86.8	ES	79.6	54.5	46.1	FP	47.1	74.9	-37.1	FS
Drăgășani	262	4.0	37.9	-89.4	ES	65.6	49.9	31.5	FP	79.4	73.4	8.2	N
Apa Neagră	280	19.0	37.4	-49.2	FS	46.4	40.1	15.7	PP	49.2	69.7	-29.4	S
Tg. Jiu	250	1.8	63.6	-97.2	ES	109.9	76.4	43.8	FP	91.9	108.8	-15.5	PS
Polovragi	210	3.7	43.8	-91.6	ES	63.5	64.0	-0.8	N	164.4	85.3	92.7	EP
Rm. Vâlcea	546	17.8	50.9	-65.0	ES	75.2	70.4	6.8	N	130.3	103.9	25.4	P
Voineasa	243	13.8	36.8	-62.5	ES	39.8	58.5	-32.0	FS	90.2	97.3	-7.3	N
Parâng	587	10.5	37.9	-72.3	ES	61.0	67.2	-9.2	N	95.1	95.5	-0.4	N
Average Oltenia	1585	53.3	53.0	0.6	N	107.8	86.3	24.9	P	198.1	114.8	72.6	EP
Ob. Lotrului	1404	15.2	41.9	-63.8	ES	62.6	56.5	7.6	N	86.0	80.0	7.4	N
		47.7				62.5				155.5			

2a. Thermal regime of April 2019

Monthly averages of air temperature were between 8.7°C at Voineasa and 13.1°C at Dr. Tr. Severin, and their deviations from normal were between -0.3°C at Polovragi and 1.2°C at Dr. Tr. Severin, which according to the Hellmann Criterion, results that April was thermally normal (N) in most of the region and warm (in the sense of warmish²) on the restricted areas of Dr. Tr. Severin, Tg. Jiu,

² The deviation class for the warm clasification (CL) in the Hellmann Criterion includes the smallest positive deviations (1.0°C 1.9°C) after those of the normal thermal class

Rm. Vâlcea, Voineasa and Ob. Lotrului (CL) (Table 3). *The average monthly air temperature* calculated for the entire region was 11.5°C, and its deviation from normal was 0.6°C, which **confirms that April was thermally normal** (N) on average for the entire Oltenia region. The average monthly temperature increase for the entire region compared to March was 2.9°C, and the normal increase is 6.3°C, which shows that from a thermal point of view, the temperature rise in April was modest.

Table 3. *The air temperature regime in Oltenia and the minimum and maximum temperature values at the soil surface in April 2019, for the area with altitude ≤600 m (N = average temperature values in April, for the period 1901-1990, M = temperature averages in April 2019; Δ = MN = temperature deviation; CH = Hellmann Criterion: CL=warmish, N=normal.)*

(Source: data processed from the ANM archive)

Meteorological station	Hm	N	M	Δ=M-N	CH	Tmin air		Tmax air		Tmin soil		Tmax soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr. Tr. Severin	77	11.9	13.1	1.2	CL	3.0	17	26.2	26	2.1	17	49.4	26
Calafat	66	11.8	12.6	0.8	N	1.4	3	26.9	26	2.6	3	32.3	1
Bechet	65	12.0	12.2	0.2	N	-1.8	3	27.7	26	0.4	3	41.9	26
Băilești	56	11.9	12.4	0.5	N	2.0	1	26.2	26	-0.3	1	33.8	27
Caracal	112	11.6	11.8	0.2	N	1.3	3	26.7	26	5.6	3	25.2	26
Craiova	190	11.5	11.5	0.0	N	2.0	1	25.6	26	1.8	3	48.0	26
Slatina	165	11.4	11.6	0.2	N	1.9	17	27.0	27	2.3	3	28.7	27
Băcleș	309	10.2	11.1	0.9	N	2.2	17	24.5	26	-	-	-	-
Tg. Logrești	262	10.3	10.9	0.6	N	-1.2	1	26.0	26	-2.5	1	43.2	26
Drăgășani	280	10.9	11.5	0.6	N	2.9	17	26.2	26	4.1	17	36.2	26
Apa Neagră	250	10.1	10.8	0.7	N	-2.0	1	25.5	26	0.5	1	34.6	26
Tg. Jiu	210	10.9	12.0	1.1	CL	0.8	1	27.3	26	0.2	1	43.2	1
Polovragi	546	10.4	10.1	-0.3	N	-0.5	4	23.8	27	-3.5	4	44.0	26
Rm. Vâlcea	243	10.8	12.0	1.2	CL	2.0	4	27.3	27	0.3	4	46.8	26
Voineasa	587	7.7	8.7	1.0	CL	-2.0	16	25.8	26	-	-	-	-
Parâng	1585	-	-	-	-	-	-	-	-	-	-	-	-
Average Oltenia	-	10.9	11.5	0.6	N	0.8	-	26.2	-	1.0	-	39.0	-
Ob. Lotrului	1404	2.0	3.1	1.1	CL	-5.5	1	18.8	26	-	-	-	-

This fact led to long periods of stagnation of vegetation development, which even caused plant degradation especially in unprotected vegetable crops. As a result, the advance of crop development recorded in March was canceled, and the stagnation periods brought the development stages to normal and even below the normal stages in certain calendar intervals. *The monthly minimums of air temperature* were recorded on the dates of 1, 3, 4, 16 and 17.IV and ranged between -2.0°C at Voineasa and Apa Neagră and 3.0°C at Dr. Tr. Severin. *The average monthly minimum temperature* for the entire region was 0.8°C. There were late local or isolated mists in the hill area, in the Subcarpathians and isolated in the extreme south of the region (Bechet), which affected the agricultural crops and the vegetation in the advanced stages of development. *The monthly maximum air*

(N) (-0.9° + 0.9°C), therefore the classification of **warmish** is more appropriate than the **warm** name assigned, when adapting the Hellmann Criterion in Romania.

temperatures were recorded in the last pentad of the month on the dates of 26 and 27.IV and ranged between 23.8°C in Polovragi and 27.7°C in Bechet, and their average for the whole region was 26.2°C, registering a small increase of 2.8°C. On the surface of the soil, the minimum temperatures were recorded in the data, 1, 3, 4 and 17.IV and ranged between -3.5°C in Polovragi and 5.6°C in Caracal, and their average for the whole region was 1.0°C. *The monthly soil surface temperature maxima* were recorded in the data of 1, 26 and 27.IV and were between 25.2°C in Caracal and 49.4°C in Dr. Tr. Severin, and their average for the entire region of was 39.0°C. *The graphs of the parameters* that characterize the air temperature in April (the average of the daily minimums, the daily averages and the average of the daily maximums), had significantly increasing trends for all the analyzed parameters (Fig. 2).

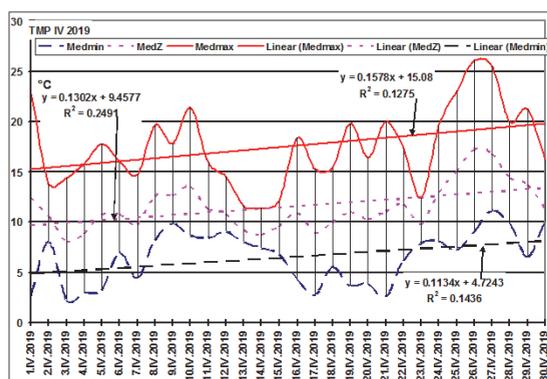


Fig. 2. Variation of the parameters that characterize the temperature in April 2019. (data processed from the ANM archive).

2b. The rainfall regime for April 2019

The monthly precipitation amounts ranged from 27.4 l/m² to 109.9 l/m² at Apa Neagră and the percentage deviations from the normal ones between -42.2% in Craiova and 79.8% at Dr. Tr. Severin, which determines classifications of the types of rainfall time on the relief steps of Oltenia from very dry (FS) on the restricted areas of Slatina and Rm. Vâlcea and excessively rainy on a restricted area at Dr. Tr. Severin (Table 3). *The average of the monthly precipitation quantities* calculated for the entire region was 62.6 l/m², and its percentage deviation from the normal was 7.6%, which shows that April, on average, was rainy. The excessively dry period was between 31.I-10.IV (39 days), and the warming of the weather from February, March and April caused negative effects on agricultural crops whose development was stagnant, and in the first 10 days during the month of April the plants wilting at certain intervals, their yellowing and even drying in certain areas. The first significant rains for agriculture were recorded on the dates of 11 and 12.IV, and the date of 12.IV was the rainiest day of April with the average of precipitation quantities for the entire Oltenia region of 15.1 l/m². In the other days of April, rainfall was insignificant or absent. The drought period in the first part of 2019 (31.I-10.IV.2019) is part of a longer drought period that started on

2.VIII.2018, interrupted only by the rainfall of January 2019 (drought periods are interrupted by brief rainy periods³).

3a. The thermal regime of May 2019

Monthly averages of air temperature were between 12.6°C in Voineasa and 17.1°C in Bechet, and their deviations from normal were between -1.0°C in Băilești and 1.0°C in Rm. Vâlcea, which according to the Hellmann Criterion shows that the May was thermally normal in most of Oltenia, except for two restricted areas, one in the Oltenia Plain at Băilești where it was cool (RC) and another in the Olt River Corridor at Rm. Vâlcea where it was warm (CL) (Table 4).

Table 4. The air temperature regime in Oltenia and the minimum and maximum temperature values at the surface of the soil in May 2019, for the area with altitude ≤ 600 m (N = normal temperature in May, for the period 1901-1990; M = temperature averages in May 2019; Δ = M-N = temperature deviation; CH = Hellmann Criterion: N=normal, RC=cool).

(Source: data processed from the ANM archive)

Meteorological station	Hm	N	M'19	Δ =M-N	CH	Tmin air		Tmax air		Tmin soil		Tmax soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr. Tr. Severin	77	17.1	16.5	-0.6	N	6.6	9	28.0	28	6.1	9	60.0	29
Calafat	66	17.3	16.8	-0.5	N	5.1	9	29.8	28	7.8	7	33.1	28
Bechet	65	17.5	17.1	-0.4	N	3.4	9	31.0	28	5.0	9	50.7	22
Băilești	56	17.4	16.4	-1.0	RC	5.1	9	29.9	28	6.6	9	38.8	26
Caracal	112	17.1	16.8	-0.3	N	5.6	9	28.7	27:28	8.7	9	36.1	28
Craiova	190	17.0	16.1	-0.9	N	5.3	8	28.4	27	6.5	8	54.7	30
Slatina	165	16.9	16.4	-0.5	N	5.7	9	28.2	27	7.1	9	34.4	29
Băceș	309	15.5	14.9	-0.6	N	4.2	8	26.4	29	-	-	-	-
Tg. Logrești	262	15.3	15.1	-0.2	N	1.9	9	26.5	27	0.6	9	47.8	26
Drăgășani	280	15.8	16.1	0.3	N	6.0	8	28.0	27	7.2	8	33.6	30
Apa Neagră	250	15.1	14.9	-0.2	N	2.0	9	26.4	26	3.0	3	40.7	26
Tg. Jiu	210	15.9	15.9	0.0	N	4.8	9	27.0	26	4.2	9	49.2	30
Polovragi	546	14.3	14.4	0.1	N	3.6	8	24.6	19	2.1	8	49.5	26
Rm. Vâlcea	243	15.4	16.4	1.0	CL	6.2	2	28.4	27	6.0	8	50.8	29
Voineasa	587	12.1	12.6	0.5	N	-0.4	9	26.1	19	-	-	-	-
Parâng	1585	-	-	-	-	-2.7	7	17.3	28	-	-	-	-
Average Oltenia	!	16.0	15.8	-0.18	N	3.9	!	27.2	!	5.5	!	44.6	!
Ob. Lotrului	1404	7.2	7.2	0	N	-1.8	9	19.5	19	-	-	-	-

The average monthly air temperature for the entire Oltenia region was 15.8°C, and its deviation from the normal was -0.18°C, which confirms that May was thermally normal (N) on average for the entire region. The increase in air temperature compared to April was 4.3°C, and the normal increase is 5.1°C, which means that May was the second consecutive month with a modest increase in temperature maintaining a low rate of plant and crop development in general. The increase of the air temperature was made from 18.V when the daily maximums reached and exceeded 25.0°C, and the daily averages exceeded 20.0°C, which is in

³ This is an important feature of the climate of Europe (not just Romania).

relation to the duration of the day which at 21.V records 15 hours and subsequently it is overcome, and at 19.VI (one month later) it reaches a maximum of 15 hours and 32 minutes (for Craiova's latitude). This increase in daytime duration occurs throughout the northern hemisphere, and at higher latitudes, the daytime duration is much longer (exceeding even 18 hours) and as a result the air heating is rapid, with the warm season beginning almost abruptly. As a result after 18.V, the growth rates of the plants intensified.

Monthly minimums of air temperature were mostly recorded on 8 and 9.V and ranged between -0.4°C in Voineasa and 6.6°C at Dr. Tr. Severin, and their average for the entire region was from 3.9°C . The monthly maxima of air temperature were mostly recorded in the data of 27 and 28.V and ranged between 24.6°C in Polovragi and

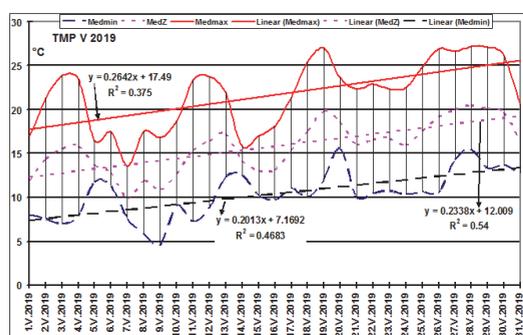


Fig.3. Variation of the parameters that characterize the air temperature in May 2019. (Data processed from the ANM archive).

31.0°C in Bechet, and their average for the entire Oltenia region was 27.2°C . On the soil surface the monthly temperature minima were mostly recorded in the data of 8 and 9.V and were between 2.1°C in Polovragi and 8.7°C in Caracal, and their average for the entire Oltenia region was 5.5°C . The monthly temperature maxima at the soil surface were recorded in the data of 22, 26, 28, 29 and 30 and were between 33.6°C in Drăgășani and 60.0°C at Dr. Tr. Severin, thus reaching specific values for the summer season. The average monthly maxima on the soil surface was 44.6°C , which characterizes the beginning of summer days. The graphs of the parameters that characterize the temperature of the air in May (the average of the daily minimums, the daily averages and the average of the daily maximums), had significantly increasing trends for all the analyzed parameters (Fig. 4).

3b. The rainfall regime of May 2019

The monthly precipitation amounts were between 37.2 l/m^2 at Bechet and 164.4 l/m^2 at Tg. Jiu (Table 2), and their deviations from the normal were between -46.4% in Băilești and 92.7% in Tg. Jiu, and according to the Hellmann Criterion they lead to classifications of the rainfall types from very dry (FS) at Băilești and Bechet in the Plain of Oltenia to excessively rainy (EP) at Calafat, Tg. Jiu and Parâng. The monthly rainfall amounts were extremely uneven, so four monthly quantities reached and exceeded 100.0 l/m^2 : 108.4 l/m^2 in Calafat, 130.3 l/m^2 in Polovragi, 164.4 l/m^2 in Tg. Jiu and 198.1 l/m^2 in Parâng, and four quantities were

<50.0 l/m²: 37.2 l/m² in Bechet, 37.6 l/m² in Băilești, 45.2 l/m² in Craiova and 49.2 l/m² in Drăgășani (Table 2), maintaining the state of pedological drought in the respective areas. *The average monthly rainfall* for the entire region was 86.0 l/m², and its percentage deviation from normal was 7.4%, which shows that on average, May was normal for the entire Oltenia region, but the low rainfall period had a space-temporal extension of 43.8% maintaining the state of atmospheric and pedological drought in the respective areas (Table 2). There are two days with significant rainfall in May: 5.V with an average rainfall for the whole region of 12.6 l/m², and 31.V with an average of 14.0 l/m², and in the other days - 9.V with an average of 6.8 l/m², 14.V with an average of 9.0 l/m² and 16.V with an average of 11.7 l/m². The latter is due to torrential rain from Tg. Jiu that in three hours totaled 80.6 l/m² (which represents 48.7% of the monthly quantity and 34.5% of the seasonal quantity), but in most measurement points, the quantities recorded were insignificant. The quantity of 80.6 l/m², registered on 16.V at Tg. Jiu is the largest rainfall recorded in 24 hours at Oltenia weather stations in spring 2019.

4. Seasonal climate characteristics of spring 2019

Seasonal average air temperatures were between 8.8°C in Voineasa and 13.3°C in Calafat, and their deviations from normal were between 1.1°C in Băilești and Craiova and 2.0°C in Drăgășani, according to the Hellmann Criterion, the 2019 spring was warm throughout Oltenia, with the exception of the mountain area of Ob. Lotrului where it was warmer (CL). *The average annual air temperature* for the entire region was 12.0°C, and its deviation from the normal was 1.5°C, which confirms that the **spring has been warm on average throughout Oltenia**. The annual precipitation amounts were between 100.2 l/m² in Băilești and 231.6 l/m² in Tg. Jiu, and their percentage deviations were between -36.5% in Băilești and 19.9% in Tg. Jiu, and according to the Hellmann Criterion, the types of seasonal pluviometric times ranged from very dry (FS) in the Băilești Plain (at Băilești and Bechet) and in the Getic Piedmont at Slatina, to rainy (P) at Tg. Jiu. As a result of the weather warming starting with 9.I, the coming of spring in 2019 was early in the whole Europe and even throughout the Northern Hemisphere, and the warming associated with the cold air advancements in the polar area in some time intervals caused the production of some climate risk phenomena, which marked the climatic evolution of this spring. These have affected agricultural crops, biocenoses and in general everything that means life. On 11.III, the pandemic influenza was decreed by the WMA. *The world will inevitably face another influenza pandemic, which is why it must be prepared for the potential devastating effects it could have and not underestimate the risks* (World Health Organization, WMA), quoted by Reuters. The threat of a influenza pandemic is omnipresent - WMA General „Director Tedros Adhanom Ghebreyesus points out: *We must be vigilant and prepared - the cost of a major outbreak of influenza will far outweigh that of prevention.* (<https://www.stiripesurse.ro/organiza-ia-mondiala-a-sanata-ii->

avertizeaza-pandemia-de-gripa-este-inevitabila_1332988.html). **The death toll in Romania was 178 deaths on 19.III.2019.**

The synoptic situation of 18.III.2019, when the European climatic record of temperature for this date was made

At the level of the Earth's surface, on 18.III.2019, at 18 UTC, at the peak of the tropical warm air (cT) advection over South-East Europe, the Azoric Anticyclone (strongly developed with values at the center of 1035 hPa), had a ridge extended to the south of the Scandinavian Peninsula (Fig. 5).

It was united over the Mediterranean and southern Europe with the East-European Anticyclone. Above the Scandinavian Peninsula and the Gulf of Bothnia was operating the Icelandic Cyclone whose thalweg was extended to the middle of the Balkan Peninsula. In the interval 12-18 UTC, this thalweg was much larger and included the south of Italy, the Adriatic Sea and a good part of the Mediterranean Sea, and also in this interval from this thalweg a weak Mediterranean Cyclone was formed (with values in the center below 1005hPa) positioned above Italy, which amplified the advection of warm air in Romania. At altitude, at the level of 500 hPa, above Europe there was a circulation of atmospheric blockage (the characteristic isohypse of 552 damgp had the form of the letter "Ω").

For Romania, at this level the air circulation was of tropical continental type (cT), advecting above our country a hot and dry air mass of Saharian origin. The aforementioned are supported by the distribution of the thermal field at the level of 850 hPa (about 1500 m altitude) (Fig. 6), where we observe the strong advection of very hot air, the 10.0°C isotherm being extended to the middle of Moldova (Romania), and that of 0.0°C (which marks the limit of hot air) exceeded the latitude of 60°N.

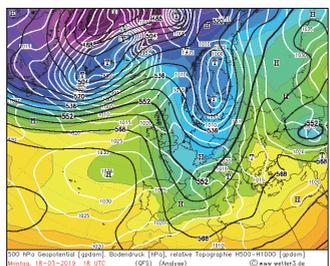


Fig. 5. Synoptic situation from 18.III.2019, 18 UTC: the geopotential field at the level of 500 hPa (approx. 5000 m, the thick black isohyps), the atmospheric pressure field at the surface of the surface (the white isohyps), the relative topography field TR500 / 1000 (light gray isohyps and color tints) (characteristic isohyps of 552 damgp - thick black curve). (www.wetter3.de).

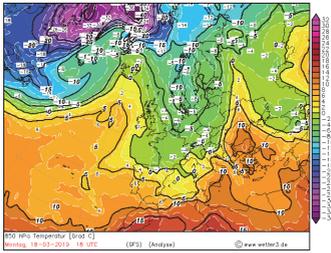


Fig. 6. *The temperature field from 18.III.2019, 18 UTC, at the level of 850 hPa (approx. 1500 m, thick black izohtpses are the main isomers, thin white izohtpses are secondary isotherms) (www.wetter3.de).*

Atmospheric traffic blockages were repeated in the first two months of the rainy summer of 2018 and then, during the autumn, winter 2018-2019 and in May and June 2019, causing significant rainfall in the country. In Romania, ***the strong instability of the weather in spring 2019 started from 20.IV.2019*** with: hail storms, tornadoes and tornado phenomena, abundant hail and large floods on certain surfaces, swollen rivers, vines that have uprooted trees, roofs of destroyed houses, etc. ***In 23.IV there were deposits of Saharan dust in Romania and much of Europe*** (tropical circulation, but overall atmospheric blockade) (Drajna, Călărăși County, about 100 kilometers from Bucharest). The tornado overturned a bus in Brâncoveanu. 39 people and 7 were injured (Romania TV). The bus was thrown from the road in the field about 50 m from the motorway.

On 30.IV.2019 in Muntenia there was a tornado with ***rain, dust, sand and stones*** on the A2 highway in Călărăși area (on the road to Constanța - the Roofing Commune of several houses in Dragalina was taken by the wind. A tornadic phenomenon (a tornado) was formed in Buzău on the same day, in several localities of the country, the appearance of tornado clouds that developed suction columns to the ground without touching the ground (this type of clouds are popularly called "dragon with tail"). In some localities of the country there was a storm, on 30.IV.2019, 18 counties were under a yellow storm code, this time in Oltenia most of the rainfall amounts were insignificant and we notice only two values: 15.4 l/m² at Polovragi and 27.8 l/m² at Parâng in the mountain area.

On 6.V.2019, the abundant hail destroyed nearly 1000 hectares in Frătești commune (Giurgiu County). Over 800 ha were destroyed with wheat and rape. And in other localities in Giurgiu County, the hail made disaster in Mihai Bravu, Budeni etc. On May 24, 2019, another tornado took place in Romania, in Bărăgan at Slobozia Nouă - Iazu, Ialomița County but of lower intensity than in Drajna. ***The abundant hail also occurred in Oltenia on 28.V***, and in Calafat, the hail grain size reached the size of a pigeon egg (most hail seeds had a diameter between 6 and 10mm) and the duration was 10 minutes but the disaster was great. ***In the evening of 29.V.2019***, a strong storm with wind intensifications caused damage in the city of Corabia, Olt County. The storm lasted 20 minutes during which time it broke 50 trees, demolished some roofs, including the one of the Danubius Technical College, causing the next day's courses to be suspended; three poles of electrical current were brought down causing the interruption of the current.

The strong warming of the weather in the Northern Hemisphere occurred once with the approach of summer days. Thus, **on 29.V.2019, a heat wave occurred in India, with maximum temperatures reaching 50.6°C (123.8°F) in the desert city of Rajasthan in Churu, approaching 0.4°C from the thermal record from 2016** (AFP • June 1, 2019)

Synoptic situation from 29.V.2019

At the level of the Earth's surface, the Azoric Anticyclone (with values at the center ≥ 1025 hPa) was united with the East-European Anticyclone (with values at the center ≥ 1020 hPa) over Central Europe (Fig. 7). To the north of this anticyclone belt the Icelandic Cyclones were operating, and to the south, a low pressure field with values slightly below 1015 hPa in northern Africa. At the level of 500 hPa there is a thalweg of the geopotential field extended to the south of Italy (568 dagp. isohypse). Under these conditions, a cool and humid air mass was advected at altitude (above the anticyclone field) over Central Europe to southern Italy and even to northern Africa (Tunis Cape). In these conditions, the strong air heating during the day caused strong accumulations and the formation of Cumulonimbus clouds, which were organized during the afternoon of the high-altitude cool air during the afternoon and evening taking on an atmospheric front.

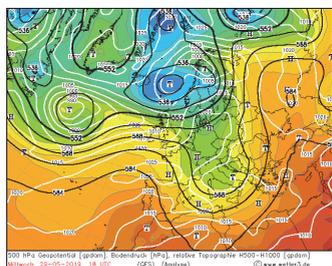


Fig. 7. Synoptic situation from 29.V.2019, 18 UTC: the geopotential field at the level of 500 hPa (approx. 5000 m, the thick black isohyps), the atmospheric pressure field at the surface of the surface (the white isohyps), the field of the relative topography TR500 / 1000 (light gray isohyps and color tints) (characteristic isohype 552 damgp - thick black curve). (www.wetter3.de)

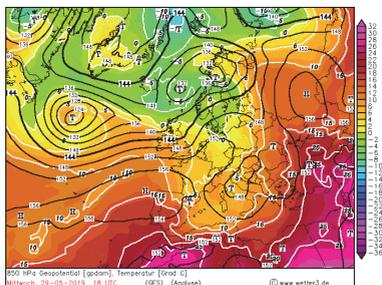


Fig. 8. Synoptic situation from 29.V.2019, at 850 hPa level, 18 UTC: geopotential field at 850 hPa level (about 1500 m, thick black isohyps), air temperature field at this level (white isohyps and tints color). (www.wetter3.de).

The storm with the intensification of the wind occurred in the area of the thermal contrast between the advected air mass and the one existing here, strongly heated. The thermal contrast was marked by a temperature difference of 7.0°C at 21 o'clock (OVR) (19.0°C at Băilești and 26.0°C at Turnu Măgurele). The synoptic situation from 29.V (which derives from the evolution from the one from 28.V), is important because in the altitude geopotential talweg, an altitude cyclone has

subsequently formed, which has persisted over Romania until 6 .VI.2019 maintaining the instability of the weather and causing torrential rains, hail, tornado phenomena, wind intensifications in many areas of the country. In Western and Eastern Europe, atmospheric blockages have occurred during this time.

4. CONCLUSIONS

In spring 2019, the climate variability was particularly high, the discharge was early marked by the increase of the average monthly temperature from February to March, of 5.9°C, determining the strong advance of the vegetation and the evolution of biocenoses. ***The early coming of spring in 2019***, after the average charge index of 467.6, was the ***6th-highest charge, in the decreasing order of the coming of spring index*** (I2016 = 543.3; I2002 = 525.7; I2007 = 499; I2008 = I208; I2008 = = 475.3; I2019 = 467.6). ***For the period 1998-2019, a single coming of spring was late in 2003 with the average index of I = 181.5***, all the others being early which shows the extent of the climatic heating in the southwest of Romania. ***The average monthly air temperature in March calculated for the entire Oltenia region was 8.6°C***, and its deviation from the normal was 4.0°C, which confirms that March was warm (C) for the whole region. ***The 4.0°C deviation of March is the largest positive deviation from the normal for the first five months of 2019, which shows that in March there was the greatest warming of the weather.*** As a result of the warm weather in March, the *contribution of the temperatures recorded this month* to the average index of discharge was 57.2%. ***On 18.III.2019 in Romania was registered the European climatic record of the hottest day of March 18th.*** During the months of April and May, the thermal regime was normal, on average, but with great variations from one period to another. The hot weather with the summer heat regime started at 18.V, when the day's duration approached that of the days of the hot season (14 hours and 53 minutes). The strong instability of the weather started from 20.IV and was accentuated in the last decade of May and culminated with torrential rains with hail, eels and tornadoes between 30.V-6.VI. March was excessively dry, and April was on average normal. On extended areas the rainfall deficit persisted throughout the spring, with moderate and excessive pedological drought. Although in the interval 30.V-6.VI the precipitations were in surplus, the arrival of the first moderate heat wave of the summer of 2019 in the interval 10-17.VI brought the drought problem again.

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