

CLIMATE ANOMALIES IN SOUTH-WEST ROMANIA IN THE SPRING OF 2020, IN THE CONTEXT OF CLIMATE CHANGE

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ABSTRACT. *Climate anomalies in south-west Romania in the spring of 2020, in the context of climate change.* The paper analyzes the climatic anomalies in Oltenia that occurred in spring 2020. After the Mediterranean winter of 2019-2020, the spring was excessively early on large areas, and on average very early. As a result, the vegetation started to develop very early, since the first part of March, and the flowering of the early fruit trees took place in the first half of March. In the first two months of spring there were 31 days in which the daily minimum temperatures were negative and there was hoar and frost on the soil surface. Thus, in March, minimum negative temperatures were registered in the intervals: 1.III, 6.III, 16-19.III, 23-31.III, ie 15 days. In April, minimum negative temperatures were registered in the intervals: 1-10.IV, 15-16.IV, 23-25.IV and 27.IV, totaling 16 days. The cooling of the weather culminated with the interval 22-25.III, in which the highest amounts of precipitation were registered in March but also in the whole cold season 2019-2020. There were blizzards that deposited a consistent layer of snow and banks formed, lasting 4 days being the longest in the cold season 2019-2020. The intense cooling of the weather after the warm winters are destructive climatic anomalies. The paper is part of an extensive series of studies on climate variability in southwestern Romania (Oltenia) in the context of climate change (I. Marinică, 2006, 2008; Marinică I., Marinică Andreea Floriana, 2016).

Keywords: late spring snow, cold air advections, climate anomalies, drought

1. INTRODUCTION

The World Meteorological Organization has classified 2019 as the second warmest in history, after 2016 (since 1850 until now). 2016 remains the warmest year ever recorded on the planet. It was marked by a very intense El Nino episode, a phenomenon that accentuated the long-term warming and caused abnormally high temperatures. Globally, the decade 2010-2019 was the warmest in the history of meteorological measurements, and after 1980, each decade was warmer than the previous one (according to the WMO). The average surface temperature of the globe increased by 1.1°C compared to the pre-industrial era (1850-1900). The average surface temperature of the Planetary Ocean shows that the last decade of 2010-2019 was also the warmest for the oceans, which absorbed 93% of the surplus energy attributed to global warming.

In Romania, 2019 was the warmest year in the history of meteorological measurements in Romania (1900-2019), and the general average exceeded the

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record previously recorded in 2015 (according to ANM, https://www.realitatea.net/stiri / Weather / Director-NMA-confirm-year-2019-the-year May-warm-from-romania-the-history-masuratorilor_5e08fe71218e354ad33ef24e). As a result, the winter of 2019-2020 was warm, being the second Mediterranean winter registered in the south of Romania after the Mediterranean winter of 2006-2007, which was the first Mediterranean winter in the history of the climate in Romania.

In Romania, winter 2019-2020 was the second warmest since 1961 and until now. The average temperature was 2.8°C above the multiannual average of the period 1981-2010. December 2019 registered a positive thermal deviation of 3.1°C, being the second warmest month from 1961-2019, after December 1982 (+ 3.4°C). January 2020, the coldest month of the year, was 1.4°C warmer than normal. The last month of winter, February 2020, was the 5th warmest month, with a deviation of 3.9°C, the warmest month of February being in 2016 (+5.7°C). (https://www.facebook.com/permalink.php?story_fbid=109179804027756&id=107346134211123).

In Oltenia, the winter 2019-2020 was *very hot* (FC) with an average of 2.89°C and the deviation from normal was 3.84°C, which means *the second warmest winter in the history of meteorological observations*, after the winter 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*. 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. *The third warm winter in descending order* of the seasonal temperature average was the winter of 2015-2016, but which was marked by January 2016 with the monthly average for the entire region of -2.58°C and the deviation from normal of -0.025°C, that is, a normal thermal month (N) of winter and with a significant layer of snow. The winter was hot or very hot in large areas of the Northern Hemisphere, and in this context in December 2019 appeared the virus Covid-19 that caused the 2020 Pandemic (WHO Declaration of 11.III.2020), particularly infectious and dangerous that penetrated all types of climate on Earth. Due to the warm winter, the spring in 2020 was, on average, very early (FTi) with the average spring (IP) index for the entire Oltenia region of 452.1 (excluding the mountain area). It was the 8th very early spring in the descending order of the values of this index registered after 1998, after the winters of 2002 with IP = 525.7, 2007 with IP = 498.1, 2008 with IP = 479.7, 2014 with IP = 475.3, 2016 with IP = 543.3, 2017 with IP = 464.4 and 2019 with IP = 467.6. In this context, vegetation started early in development. *Phenological observations* show that: -In the interval 1-5.III there was swelling of buds on apricots, wax cherries, almonds, sour cherries, cherries. -The willow and the ligustru (the dogwood from which the hedge is made) came into leaf. -On 5.III the wax cherry

flowers opened. -In 8.III the first apricot blossoms, and on 13.III.2020 the early species of fruit trees were in bloom (almonds, apricots, peaches, wax cherries, etc.). If the warm weather had continued we would have had early fruits and vegetables. The spring months, especially March and April, were accompanied by special climatic anomalies which caused special material and economic damage in agriculture.

We will further analyze the *climatic anomalies* of this very early spring.

2. DATA AND METHODS USED

To carry out the work we used data from the ANM archive and those from international databases, existing synoptic maps on the Internet from international weather forecasting centers, ANM website, satellite information, information published in the written press and the results of our processing.

3. RESULTS AND DISCUSSIONS

3.1. Climatic characteristics of March 2020

Climatic regime of March 2020

The monthly average temperatures were between 5.2°C at Voineasa and 8.4°C at Dr. Tr. Severin. Their deviations from the normal values were between 1.7°C in Băilești and 3.6°C in Drăgășani and Polovragi, which according to the Hellmann criterion, shows that the type of thermal weather in March was warm (C) in most of Oltenia except for two small areas in the Oltenia Plain, Calafat and Băilești where it was warm (CL). The monthly average air temperature calculated for the entire region was 7.2°C, and its deviation from normal was 2.6°C, which confirms that in March, the weather was warm (C), on average, for the whole region (Table 1). *The maximum monthly temperatures* were recorded before the spring equinox on 13.III and were between 20.1°C at Polovragi and 24.1°C at Caracal, and their average for the whole region of 22.8°C. *The monthly minimum air temperatures* were recorded, mostly on 17.III (4 days after the date of the thermal maximums and also before the spring equinox) and were between -7.5°C at Tg. Logrești and -1.9°C at Dr. Tr. Severin, and their average for the entire region was -4.2°C. There were six days in which the daily average of the temperature minimums was negative (most starting with 16.III, ie on 1, 16, 17, 23, 24 and 25.III). As a result, *the climatic anomaly of March*, which occurs frequently between 23-25.III, occurred and was particularly intense and destructive given the advanced stages of vegetation development and especially of fruit trees.

Table 1. Oltenia air temperature regime and minimum and maximum ground surface temperature values in March 2020 (Hm = weather station altitude, Δ = MN = deviation from the average temperature in March, CH = Hellmann criterion, NIII = temperature averages for March calculated for the period 1901-1990 - normal; MIII = average temperatures in March 2020)

Meteorological station	Hm	NIII	MIII	Δ =M-N	CH	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr. Tr. Severin	77	5,9	8,4	2,5	C	23,5	13	-1,9	17	42,4	28	-5,8	17
Calafat	66	5,6	7,5	1,9	CL	23,3	13	-2,9	17	25,9	13	-2,0	25
Bechet	65	5,4	7,4	2,0	C	24,0	13	-5,5	17	25,8	13	-1,8	17
Bailesti 56		5,4	7,1	1,7	CL	22,4	13	-3,7	17	31,3	12	-4,8	17
Caracal	112	4,9	7,4	2,5	C	24,1	13	-3,1	16	28,0	21	-1,9	16
Craiova	190	5,1	7,4	2,3	C	22,9	13	-3,2	17	39,6	21	-7,5	17
Slatina	165	5,0	7,6	2,6	C	23,0	13	-4,9	17	24,8	21	-1,9	17
Bacles	309	4,5	6,8	2,3	C	21,9	13	-3,0	16	-	-	-	-
Tg. Logrești	262	3,6	6,3	2,7	C	22,3	13	-7,5	17	38,3	21	-8,6	17
Dragasani	280	4,7	8,3	3,6	C	23,4	13	-2,0	17	26,0	21	-3,0	25
Apa Neagră	250	4,2	6,5	2,3	C	23,4	13	-6,5	17	23,2	13	-2,5	17
Tg. Jiu	210	4,8	7,8	3,0	C	22,4	13	-4,8	17	33,2	21	-5,4	17
Polovragi	546	3,0	6,6	3,6	C	20,7	13	-5,4	17	32,8	20	-7,8	17
Rm. Valcea	243	5,0	8,3	3,3	C	23,0	13	-3,5	17	38,8	21	-6,2	17
Voineasa	587	2,4	5,2	2,8	C	21,6	13	-5,4	17	-	-	-	-
Parang	1585	-	-	-	-	-	-	-	-	-	-	-	-
Average Oltenia	-	4,6	7,2	2,6	C	22,8	-	-4,2	-	31,5	-	-4,6	-
Ob. Lotrului	1404	-2,4	0,1	2,5	C	14,4	13	-10,4	16	-	-	-	-

(Source: data processed from the ANM archive)

Isolated or local minimum negative temperatures were also recorded in the data of 18, 19, 20, 26, 27, 28, 29, 30 and 31.III, we have 16 days in which negative minimums were recorded, of which 14 days were after 15.III and after the *flowering phenophase* of early fruit trees. The intense cooling of the weather in the second part of March is *a particularly destructive climatic anomaly*, especially in the years that occur after the warm winters. *At the surface of the soil the maximum temperature values* were recorded on 12, 13, 20, 21 and 28.III and were between 23.2°C on 13.III at Black Water in the area of subcarpathian depressions and 42.4°C, in the extreme west of the region to Dr. Tr. Severin on 28.III, and their average for the whole region was 31.5°C. The maximum values of temperature at the soil surface were all positive, and the lowest were recorded on 24.III when their average for the entire region was 2.7°C. The highest daily average of the thermal maximums at the soil surface was 30.7°C on 21.III (three days before the lowest daily average), which shows their great variability in March. *The minimum values of the temperature at the soil surface* were registered, most on 17.III (Table 1) and were between -8.6°C at Tg. Jiu reach the hills

and -1.8°C at Bechet in the south of the Oltenia Plain. Their average for the whole region was -4.6°C . The daily averages for the entire region of the soil surface temperature were negative in 11 days (data of 1, 2, 16, 17, 18, 19, 24, 25, 26, 7 and 28.III), the lowest being on of 17.III, of -4.4°C . As a result of these values, in March there was frost on the ground and in the air and significant thermal alternations from positive temperatures during the day to negative temperatures at night, which increased the destructive effect of temperature on fruit trees. **The graphs of the variation** of the air temperature parameters (daily averages of minimums, daily averages and daily averages of thermal maximums for the whole region), had **decreasing linear trends**, of which the strongest decreasing was the average daily minimums whose decrease coefficient was -0.1499 (Fig. 1).

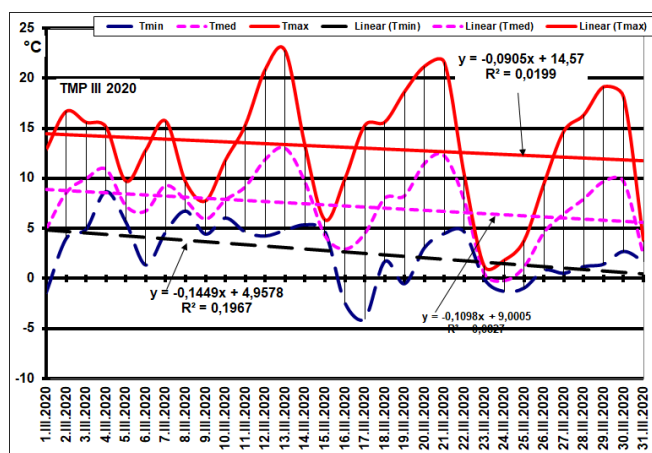


Fig. 1. The variation of the parameters that characterize the air temperature in March 2020, calculated for the whole region (average daily minimums, daily averages and average daily maximums) (Source: data processed from the ANM Archive)

The decreasing linear trend marks **the climatic anomaly of March 2020**, which consists in the unnatural cooling of the weather in March, due to the four cooling intervals: 4-5.III, 8-10.III, 14-16.III, 22-26.III and 31.III-2.IV which totaled 15 days in March and 2 days in April. Cooling intervals were also recorded in April and May.

The rainfall regime of March 2020

The monthly precipitation amounts recorded in March were between 50.0 mm at Slatina and 108.8 mm at Apa Neagră (Table 2).

The percentage deviations of the monthly precipitation amounts from normal were between 33.3% in Slatina and 127.8% in Calafat, and according to the Hellmann criterion, the calibrations of the types of rainfall were excessively rainy (EP) much of the region (Table 2). The average monthly rainfall calculated for the entire region was 71.5 mm, and its percentage deviation from normal was 79.3%, which confirms **that March was excessively rainy** on average for the

entire region. After the winter 2019-2020 deficient in rainfall, the excess rainfall in March restored the water reserve in the soil, so that on 31.III.2020, on the soil depth 0-100 cm, in the autumn wheat crop, the moisture reserve of the soil was located in satisfactory limits to close to optimal and optimal, in Oltenia.

Table 2. Precipitation amounts (mm) recorded in spring 2020 (Σ), compared to normal values (N for the period 1901-1990), deviation ($\Delta\%$) and the type of rainfall according to the Hellmann criterion (CH). (Voineasa and Băcleș weather stations are not taken into account, with the sensor covered in the cold season)

Meteorological station	Hm	March 2020				April 2020				May 2020			
		Σ III	N	$\Delta\%$	CH	Σ IV	N	$\Delta\%$	CH	Σ V	N	$\Delta\%$	CH
Dr. Tr. Severin	77	72,7	49,3	47,5	FP	0,3	49,9	-99,4	ES	66,4	80,7	-17,7	PS
Calafat	66	86,8	38,1	127,8	EP	12,2	48,6	-74,9	ES	98,2	60,8	61,5	EP
Bechet	65	68,7	36,3	89,3	EP	4,2	49,4	-91,5	ES	56,6	58,6	-3,4	N
Băilești	56	75,3	38,3	96,6	EP	8,1	47,3	-82,9	ES	112,5	70,1	60,5	EP
Caracal	112	51,6	35,7	44,5	FP	7,0	64,0	-89,1	ES	62,8	61,4	2,3	N
Craiova	190	70,1	31,5	122,5	EP	0,5	56,5	-99,1	ES	63,3	60,6	4,5	N
Slatina	165	50,0	37,5	33,3	FP	3,8	76,4	-95,0	ES	101,5	64,8	56,6	EP
Băcleș	309	29,3	43,1	-32,0	FS	0,9	40,1	-97,8	ES	95,4	74,9	27,4	P
Tg. Logrești	262	73,3	37,9	93,4	EP	1,4	54,5	-97,4	ES	119,6	73,4	62,9	EP
Drăgășani	280	73,6	37,4	96,8	EP	0,8	58,5	-98,6	ES	109,4	69,7	57,0	EP
Apa Neagră	250	108,8	63,6	71,1	EP	2,9	43,1	-93,3	ES	116,3	108,8	6,9	N
Tg. Jiu	210	67,5	43,8	54,1	EP	1,9	45,1	-95,8	ES	128,9	85,3	51,1	EP
Polovragi	546	103,8	50,9	103,9	EP	7,2	47,4	-84,8	ES	112,8	103,9	8,6	N
Rm. Vâlcea	243	73,6	36,8	100,0	EP	4,9	70,4	-93,0	ES	92,3	97,3	-5,1	N
Voineasa	587	36,5	37,9	-3,7	N	10,0	67,2	-85,1	ES	64,5	95,5	-32,5	FS
Parâng	1585	101,6	53,0	91,7	EP	17,1	86,3	-80,2	ES	137,1	114,8	19,4	PP
Average Oltenia	-	71,5	41,9	79,3	EP	5,2	56,5	-90,5	ES	96,1	80,0	20,1	p
Ob. Lotrului	1404	93				12,4	86,3	-85,6	ES	100			

(Source: data processed from the ANM archive)

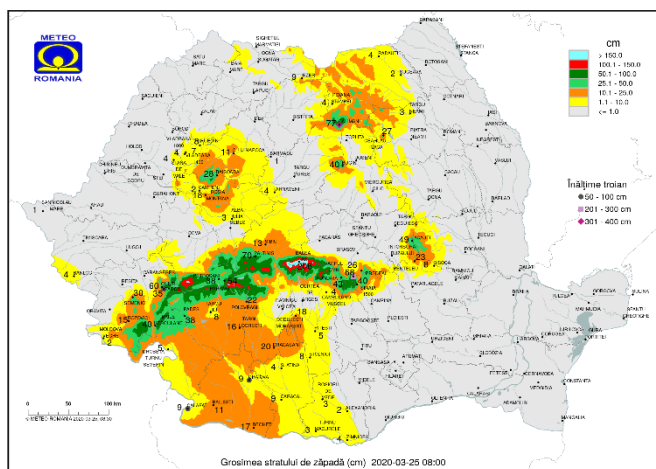


Fig. 2. Snow cover on 25.III.2020 at 08 (OIR)
(Source: ANM)

Between 22.III.2020 at 20-26.III.2020 at 08 there were *significant precipitations that deposited a consistent layer of snow* with a maximum thickness of 38 cm at Apa Neagră and 68 cm at Ob. Lotrului on 25.III.2020 (Fig. 2). This layer of snow had the longest duration of the cold season 2019-2020 (4 days) and was 18 cm higher than the maximum thickness recorded by the ephemeral layer in February 2020 and the highest in the entire cold season 2019-2020. These snows completely destroyed the flowers and fruits already formed in almonds, peaches, apricots and cherry plums.

3.2. Climatic characteristics of April 2020

Climatic regime of April 2020

The monthly average temperatures were between 7.9°C at Voineasa and 12.9°C at Dr. Tr. Severin, and their deviations from normal were mostly positive and ranged between -0,2°C at Tg. Logrești and 1.7°C in Drăgășani. According to the Hellmann criterion, April was thermally normal (N) in most of Oltenia, except for three small areas where it was warm (CL) at Dr. Tr. Severin, Băcleș and Drăgășani (Table 3), aspect determined by local conditions. The monthly average air temperature calculated for the whole region was 11.4°C, and its deviation from normal was 0.5°C, which confirms that, on average, April was thermally normal. However, the cold and warming of the weather continued to cause significant damage to agriculture. *The monthly minimums of air temperature* were all negative and were recorded in the data of 1, 3 and 7.IV being between -4.7°C at Tg. Logrești and -0.9°C at Dr. Tr. Severin. The average monthly temperature for the entire Oltenia region was -3.3°C.

Table 3. The air temperature regime in Oltenia and the minimum and maximum surface temperature values in April 2020 ($\Delta = MN =$ deviation from the normal average temperature in April, CH = Hellmann criterion, NIV = average temperatures for April calculated for the interval 1901-1990 - normal; MVII = average temperatures in April 2020, CH = Hellmann criterion)

Meteorological station	Hm	NIV	MIV	$\Delta = M - N$	CH	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr. Tr. Severin	77	11,9	12,9	1,0	CL	28,6	19	-0,9	3	56,3	16	-2,9	3
Calafat	66	11,8	12,4	0,6	N	29,4	19	-2,1	3	32,0	29	-0,1	2
Bechet	65	12,0	11,9	-0,1	N	29,0	19	-4,5	7	36,2	19	-0,5	23
Băilești	56	11,9	11,9	0,0	N	28,3	19	-2,2	3	34,0	28	-3,0	3
Caracal	112	11,6	11,9	0,3	N	27,9	19	-1,5	3	35,4	29	0,0	1
Craiova	190	11,5	12,1	0,6	N	27,3	19	-2,2	1	51,7	28	-4,4	7
Slatina	165	11,4	11,8	0,4	N	27,1	19	-2,3	7	32,0	28	-1,1	7
Băcleș	309	10,2	11,5	1,3	CL	26,7	19	-2,2	1				
Tg. Logrești	262	10,3	10,1	-0,2	N	26,0	19	-4,7	3;7	45,8	29	-5,6	7

Drăgășani	280	10,9	12,6	1,7	CL	26,0	19	-2,3	1	28,2	29	0,2	1
Apa Neagră	250	10,1	10,3	0,2	N	27,0	19	-4,4	7	32,7	28	-2,4	7
Tg. Jiu	210	10,9	11,6	0,7	N	26,8	19	-2,7	3	48,1	30	-4,0	7
Polovragi	546	10,4	10,6	0,2	N	23,4	19	-4,3	1	41,8	17	-9,0	1
Rm. Vâlcea	243	10,8	11,7	0,9	N	25,5	29	-1,7	1	53,1	30	-4,0	7
Voineasa	587	7,7	7,9	0,2	N	24,7	17	-4,4	7				
Parâng	1585							-9,7	1				
Average Oltenia	-	10,9	11,4	0,5	N	26,9		-3,3		40,6		-2,8	7
Ob. Lotrului	1404	2,0	2,4	0,4	N	17,0	19	-10	3				
PETROȘANI	607					21,9	17	-4,8	3	26,6	19	-6,0	7

(Source: data processed from the ANM archive)

Minimum negative temperatures in the air, local or isolated, were recorded *in the first 10 days of April*, accompanied by *hoar and frost in the air and soil*, which caused significant damage to vegetable growing, stagnant growth and delayed planting seedlings in the field

The monthly maximum air temperatures were recorded mostly on 19.IV and were between 24.1°C in Voineasa and 29.4°C in Calafat, and *their average for the whole region* was 26, 9°C, which shows a massive increase in air temperature between 17-21.IV.

There were three intervals of increasing temperature maximums: 3-13.IV, 16-19.IV and 22-30.IV totaling 24 days.

At the soil surface, the monthly temperature minimums were mostly negative, recorded in the data of 1, 2, 3 7 and 23.IV and were between -9.0°C at Polovragi and 0.2°C at Drăgășani. *The average monthly minimum surface temperature* for the entire region was -2.8°C. Negative monthly daily lows at the surface of the soil, local or isolated, accompanied by frost and frost were recorded in 15 days in April, of which the last day was on 25.IV, which shows that the *phenomena of frost late to the ground surface and frost*, over large areas, locally or isolated, occurred in April in many days. *The monthly maximum temperatures at the soil surface* were recorded most in the last pentad of the hazelnut on the dates of 28 and 29.IV and were between: 28.2°C in Drăgășani and 56.3°C in Dr. Tr. Severin, and their average for the entire region was 40.6°C, which means *summer temperatures and high temperature alternations from day to night* that amplified the *thermal stress on the plants*. The *graphs of variation of the parameters* that characterize the air temperature (average daily minimums, daily average and average daily maximums) calculated for the entire region had strong upward trends, and that of daily thermal maximums was the highest (0.3243) (Fig. 3).

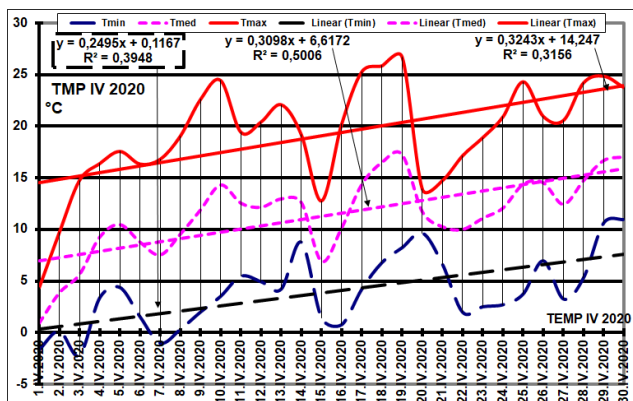


Fig. 3. The variation of the parameters that characterize the air temperature in April 2020, calculated for the entire region (average daily minimums, daily averages and average daily maximums) (Source: data processed from the ANM Archive)

These large thermal alternations in the air and at the ground surface constitute climatic anomalies.

Pluviometric regime of April 2020

The monthly amounts of precipitation recorded in April were between 0.3 mm in Dr. Tr. Severin and 12.2 mm in Calafat, and their percentage deviations from normal were between -99.4% in Dr. Tr. Severin and -74.9% in Calafat, which according to the Hellmann criterion, shows that April was excessively dry (ES) throughout Oltenia. *The average monthly quantity* calculated for the whole region was 5.2 mm, and its percentage deviation from normal was -90.5%, confirming that April was excessively dry (ES). April was *the driest month in the first 8 months of 2020*. The drought in April affected the entire country. Thus, on April 30, 2020, in the autumn wheat crop, on the soil depth 0-100 cm, there were moisture deficits (moderate, strong and extreme pedological drought), in Moldova, Dobrogea, Muntenia, Banat, Crişana, Transylvania and Maramureş, most of Oltenia. Isolated in the north of Oltenia, the water supply in the soil was within satisfactory limits. In the 0-20 cm layer (field), the soil moisture reserve was in low limits (moderate pedological drought) and particularly low (strong and extreme pedological drought), in Moldova, Dobrogea, Banat, Crişana and Maramureş, on surfaces extensive agricultural in Muntenia and Transylvania, locally in the north, east and south of Oltenia. The degree of water supply of the soil had satisfactory values, locally in the center, east and southwest of Oltenia, south, west and northwest of Muntenia, northwest, center and south of Transylvania (according to ANM). The drought of April is a particularly destructive climatic anomaly, because the strong increase of the maximum temperature in the air and at the soil surface caused gradual forcing of the plant development, the increase of water consumption and the appearance of water deficit in the soil layer at depth 0 - 1 m. In the interval 24.III-I.V, for 39 days, the precipitations were insignifi-

cant, and the first significant precipitations for agriculture were registered in the interval 2-3.V. As a result, there was damage to all types of crops, delayed emergence in spring crops, and straw crops there was a deficit in stem and ear growth which led to significant crop losses and difficulties in the harvesting process.

3.3. Climatic characteristics of May 2020

Climatic regime of May 2020

The monthly average temperatures were between 12.4°C in Voineasa and 17.7°C in Calafat, and their deviations from normal were between -0.9°C in Craiova and 0.4°C in Calafat and Rm. Vâlcea. According to the Hellmann criterion, *May was thermally normal* throughout the Oltenia region. *The monthly average air temperature* calculated for the whole region was 15.7°C with a deviation from normal of 0.28°C, which confirms that *May was the average thermal normal* for the whole region (Table 4).

Table 4. The air temperature regime in Oltenia and the minimum and maximum surface temperature values in May 2020 (Hm = weather station altitude, alt = MN = temperature deviation, CH = Hellmann criterion, NV = temperature averages for August calculated for the period 1901- 1990 - normal; MV = average temperatures in May 2020).

Meteorological station	Hm	NV	MV	$\Delta=M-N$	CH	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr.Tr. Severin	77	17,1	17,1	0,0	N	29,9	11	6,9	9	57,4	9	3,5	5
Calafat	66	17,3	17,7	0,4	N	32,3	11	6,6	9	35,3	11	8,9	23
Bechet	65	17,5	16,9	-0,6	N	33,0	11	4,0	9	38,7	11	4,6	8
Băilești	56	17,4	16,6	-0,8	N	30,7	11	5,7	5	37,8	14	4,4	5
Caracal	112	17,1	16,7	-0,4	N	31,7	11	5,4	7	37,7	11	3,4	13
Craiova	190	17,0	16,1	-0,9	N	29,7	11	6,1	5	54,5	11	2,5	7
Slatina	165	16,9	16,1	-0,8	N	29,7	11	4,6	8	32,3	11	5,4	7
Băcleș	309	15,5	15,1	-0,4	N	28,5	11	5,5	5	-	-	-	-
Tg. Logrești	262	15,3	14,5	-0,8	N	28,5	11	1,6	8	47,2	11	1,4	5
Drăgășani	280	15,8	16,0	0,2	N	29,2	11	6,7	7	31,8	11	7,5	7
Apa Neagră	250	15,1	14,9	-0,2	N	27,6	11	1,4	8	39,5	16	2,6	8
Tg. Jiu	210	15,9	15,7	-0,2	N	28,2	11	3,7	8	49,4	11	1,2	8
Polovragi	546	14,3	14,1	-0,2	N	26,5	11	2,8	22	50,5	15	1,7	7
Rm.Vâlcea	243	15,4	15,8	0,4	N	29,0	11	5,4	27	56,5	16	4,3	27
Voineasa	587	12,1	12,4	0,3	N	28,9	15	1,8	5	-	-	-	-
Parâng	1585	-	-	-	-	19,5	15	-1,4	7	-	-	-	-
Average Oltenia	-	16,0	15,7	-0,28	N	28,9	-	4,2	-	43,7	-	4,0	-
Ob. Lotrului	1404	7,2	7,5	0,3	N	23,5	15	-2,4	8	-	-	-	-
Petroșani	-	12,3	-	-	-	25,3	11	1,5	9	36,1	9	1,2	8

(Source: data processed from the ANM archive)

The minimum monthly air temperature values were recorded in the data of 5, 7, 8, 9, 22 and 27.V and were between 1.4°C at Apa Neagră and 6.9°C at Dr. Tr. Severin, and their average for the entire region was 4.2°C. **The maximum monthly thermal temperatures of the air** were recorded, most of them, on 11.V and were between 26.5°C at Polovragi and 33.0°C at Bechet, which shows a massive and rapid heating of weather in the range 8-11.V after the accentuated cooling in the range 6-7.V.

Monthly soil surface temperatures were recorded at 5, 7, 8, 13 and 27.V and ranged from 1.2°C to Tg. Jiu and 8.9°C in Calafat, and their average for the whole region was 4.0°C. The monthly maximum temperatures at the soil surface were recorded the most on 11.V and were between 31.8°C at Apa Neagră and 57.4°C at Dr. Tr. Severin, and their average for The whole Oltenia region was 43.7°C, which means summer temperatures. The temperature anomaly of May that occurs frequently in the last decade of the month and consists in the accentuated cooling of the weather, this year was attenuated and only isolated in the Olt Corridor (at Rm. Vâlcea) and the extreme southwest (Calafat) of was noticed. **The graphs of variation of the parameters** that characterize the air temperature (average daily minimums, daily average and average daily maximums) calculated for the entire region had decreasing trends, and that of daily thermal maximums was the lowest (-0.0373) (fig. 4). **The decrease of the air temperature in May** is a **climatic anomaly**, because at 20.V the length of the day reaches and then exceeds 15 hours, the maximum duration being 15 hours and 32 minutes which are recorded between 19-24.VI.

Pluviometric regime of May 2020

The monthly precipitation amounts recorded in May were between 56.6 mm at Bechet and 128.9 mm at Tg. Jiu, and their deviations from normal were between -32.5% in Voineasa and 62.9% in Tg. Logrești.

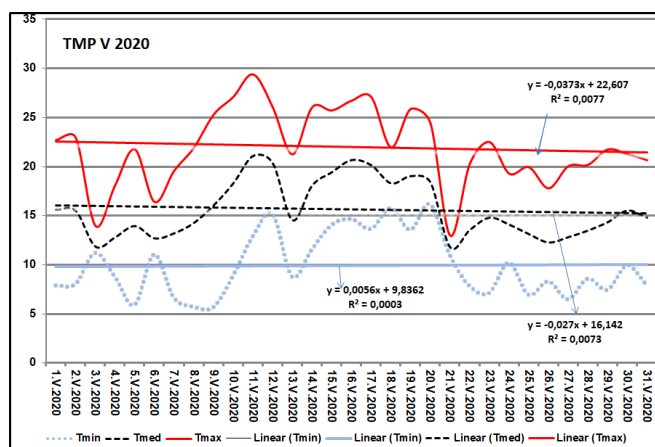


Fig. 4. The variation of the parameters that characterize the air temperature in May 2020, calculated for the whole region (average daily minimums, daily averages and average daily maximums) (Source: data processed from the ANM Archive)

According to the Hellmann criterion, **the month of May was an excess of rainfall** in most of Oltenia, in many areas of excessive rainfall (EP) (Table 2). **The average monthly rainfall** for the entire region was 96.1 mm, and its percentage deviation from normal was 20.1% which means, according to the Hellmann criterion, a rainy month (P). As a result of these precipitations, the **water supply in the soil** was partially restored for spring crops, in the soil layer with a depth of 0-50 cm and less for the soil layer with a depth of 0-100 cm. At the level of the whole country, on 29.V.2020, the water content of the soil on the depth of 0-100 cm, in the autumn wheat crop, was within low and particularly low limits, **the pedological drought** having different degrees of intensity, respectively moderate, strong and extreme, in Moldova, Dobrogea, Banat and Crișana, most of Muntenia and Transylvania, locally in the center, east and south of Oltenia. The soil moisture reserve had satisfactory values and close to the optimum, in the north, east and southwest of Oltenia, isolated in the northeast of Muntenia and Transylvania, north of Maramureș, in **the non-irrigated corn crop**, in the soil layer 0-50 cm, there were deficits of humidity (moderate, strong and extreme pedological drought), in Dobrogea, on large agricultural areas in Banat, north, local east, center, west, south and southeast of Moldova, east, center, south and south-western Transylvania, western and southern Crișana, eastern, isolated in southern and southwestern Muntenia. **The degree of soil water supply** was within satisfactory to near optimal and optimal limits, in Maramureș and Oltenia, on large agricultural areas in Muntenia, north, locally in central and southern Transylvania, east, center, south and southwest Moldova, isolated northeast of Banat, west of Crișana, (after ANM).

3.4. Seasonal climatic characteristics of the spring of 2020

Thermal regime of the spring of 2020

Mediile anotimpuale de temperatură au fost cuprinse între 8,5°C la Voineasa and 12.8°C in Dr. Tr. Severin, and their deviations from normal were between 0.3°C in Băilești and 1.8°C in Drăgășani.

According to the Hellmann criterion, spring 2020 was warm (CL) and warm (C) throughout Oltenia (Table 5). **The seasonal average air temperature** for the entire region was 11.4°C, and its deviation from normal was 0.9°C, and according to the Hellmann criterion, spring was warm (CL), on average, for the entire Oltenia region. **The seasonal amounts of precipitation** were between 111.0 mm at Voineasa and 228.0 mm at Apa Neagră, and the percentage deviations from normal were between -44.7% at Voineasa and 34.9% at Calafat.

Table 5. Overall thermal and pluviometric regime of spring 2020 (Hm = altitude of the weather station, P2020 = average temperature values in spring 2020 (°C), NtP = normal values of seasonal averages of spring temperature (°C), $\Delta = \text{PN}$ = deviations compared to normal (°C), SP = sum of precipitation in spring 2020 (l/m²), NP = normal values of spring precipitation (l/m²), $\Delta = \text{SN}$ = deviations from normal (l/m²), $\Delta\%$ = percentage deviations from normal, CrH = Hellmann criterion).

Meteorological station	Hm	Thermal regime (°C)				Pluviometric regime (l/m ²)				
		NtP	P2020	$\Delta = \text{P-N}$	CrH	SP2020	NP	$\Delta = \text{S-N}$	$\Delta\%$	CrH
Dr. Tr. Severin	77	11,6	12,8	1,2	C	139,4	186,5	-47,1	-25,3	S
Calafat	66	11,6	12,5	0,9	CL	197,2	146,2	51,0	34,9	FP
Bechet	65	11,6	12,1	0,5	N	129,5	143,5	-14,0	-9,8	PS
Băilești	56	11,6	11,9	0,3	N	195,9	157,8	38,1	24,1	P
Caracal	112	11,2	12,0	0,8	CL	121,4	142,2	-20,8	-14,6	PS
Craiova	190	11,2	11,9	0,7	CL	133,9	135,2	-1,3	-1,0	N
Slatina	165	11,1	11,8	0,7	CL	155,3	149,7	5,6	3,7	N
Băcleș	309	10,1	11,1	1,0	CL	125,6	172,5	-46,9	-27,2	S
Tg. Logrești	262	9,7	10,3	0,6	CL	194,3	161,2	33,1	20,5	P
Drăgășani	280	10,5	12,3	1,8	C	183,8	147,2	36,6	24,9	P
Apa Neagră	250	9,8	10,6	0,8	CL	228,0	248,8	-20,8	-8,4	N
Tg. Jiu	210	10,5	11,7	1,2	C	198,3	193,1	5,2	2,7	N
Polovragi	546	9,2	10,4	1,2	C	223,8	225,2	-1,4	-0,6	N
Rm. Vâlcea	243	10,4	11,9	1,5	C	170,8	192,6	-21,8	-11,3	PS
Voineasa	587	7,4	8,5	1,1	C	111,0	200,6	-89,6	-44,7	ES
Parâng	1585					255,8	254,1	1,7	0,7	N
Media Oltenia	-	10,5	11,4	0,9	CL	172,8	178,5	-5,75	-3,2	N
Ob. Lotrului	1404	2,3	3,3	1,0	CL	205,4				
Petroșani						205,7				

(Source: data processed from the ANM archive)

According to the Hellmann criterion, the spring was very rainy (FP) on a small area in the southwest of the region at Calafat, rainfall deficit in Mehedinți, in the Olt Corridor in Caracal and Rm. Vâlcea, in the south of Dolj County, and normal in Craiova, Slatina, Apa Neagră, Tg. Jiu, Polovragi and Parâng.

The seasonal average of precipitation amounts for the entire Oltenia region was 178.5 mm, and its percentage deviation from normal of -3.2% which shows that *on average spring 2020 was normal rainfall* (N) for the entire Oltenia region.

3.5. Cooling weather in spring 2020

Frequent advections of cold air caused the registration of negative minimum temperatures in March and April with extensive, local or isolated, which caused special damage in the field of fruit growing, vegetables and agriculture in general. Thus, in March, minimum negative temperatures were registered in the intervals: 1.III, 6.III, 16-19.III, 23 / 31.III, ie 15 days. In April, minimum negative temperatures were registered in the intervals: 1-10.IV, 15-16.IV, 23-25.IV and 27.IV, totaling 16 days. So in March and April there were 31 days in which negative thermal minimums were recorded accompanied by frost and frost in the air and on the ground surface.

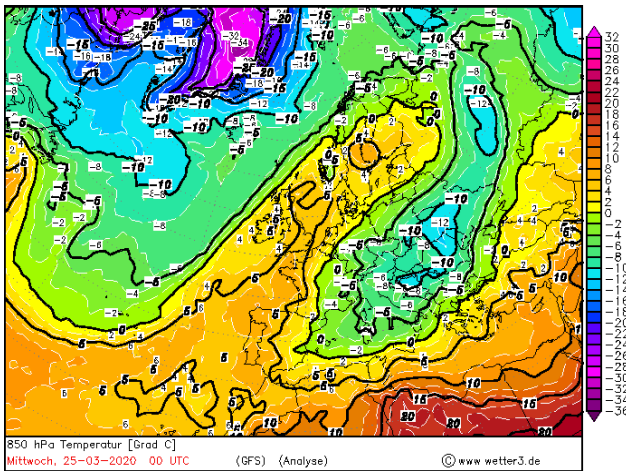


Fig. 5. The temperature field above Europe, at the level of 850 hPa, on 25.III.2020 at 00 UTC. (after www.wetter3.de)

Although normally in March the negative temperatures recorded after 20.III are warned by meteorological messages, this spring due to the warm Mediterranean winter and the development of very early vegetation, the negative temperatures in March were a climate risk and an anomaly. After the thermal field at the level of geopotential 850 hPa (about 1500 m altitude), *the most intense advection of cold air in March*, above Oltenia, occurred on 24 and 25.III when the isotherm of -10°C was positioned above Oltenia, (Fig. 5). At this time the advection of cold air over Europe was so intense that the 0°C isotherm reached the western coast of Spain, the northern coast of Sicily, half of Greece, the northwestern coast of Turkey, the western half of the Black Sea, being one of the the most intense and extensive cold air advections in the last pentad of March, recorded after 1990. *A cold air advection over Oltenia and Europe almost as intense and extensive occurred on 1.IV when the isotherm of 0°C was positioned above Oltenia.* Intense cold air advections also occurred on the dates of 15 and 16.III, when the isotherm of -5°C was positioned above Oltenia. These narrow and intense advections of cold air over Europe, after the Mediterranean winter (which has occurred in much of Europe), are climate anomalies.

3.5. Late spring snows from 22-25.III.2020

Between 22-25.III.2020 were registered the highest amounts of precipitation in March, of which the most important on 22 and 23.III. The precipitation amounts recorded in this interval were between 24.0 mm in Calafat and 57.6 mm in Apa Neagră, which is a percentage of the monthly total for March between 27.6% in Calafat and 64.1% in Caracal, being the richest precipitation interval in the first 2 months of spring.

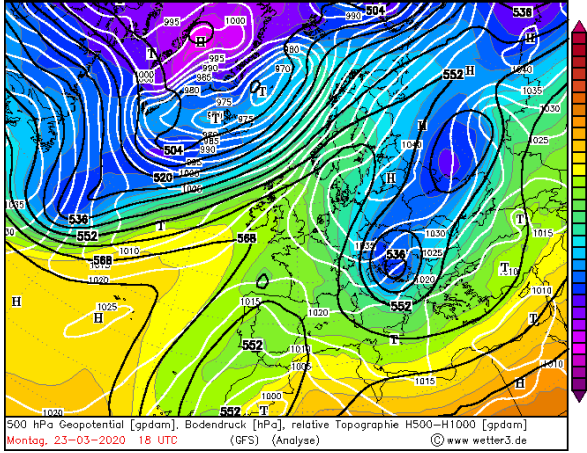


Fig. 6 The pressure field above Europe, at ground level, spread over the geopotential field at the level of 500 hPa, and the relative topography field TR500 / 1000 on 23.III.2020 at 18 UTC (after www.wetter3.de)

Precipitation started on the evening of 21.III in the form of rain and quickly turned into sleet and then snow. The thickest layer of snow in the cold season 2019-2020 was formed with maximum values between 4 cm at Rm. Vâlcea and 38 cm at Apa Neagră, and at the mountain 68 cm at Ob. Lotrului (Fig. 2) and with the longer duration (4 days). In some intervals *the snow was blizzard and snow trojans formed.*

The synoptic causes that determined these snowfalls were an atmospheric blocking circulation over Europe produced by the anticyclonic field, in which the Scandinavian Anticyclone was positioned with a strong center of 1040 hPa, above Northeast Europe south of the Scandinavian Peninsula (Fig. 6). The coupling of this strong anticyclonic field with the weakly depressed field in the Mediterranean Sea determined these snows.

Later, on the 24.III, above the eastern Mediterranean Sea, a Mediterranean Cyclone was individualized, which amplified the precipitations and determined the blizzard situation. The air masses observed over Romania were: cold polar continental (cPk) (cold and dry) from the north and northeast in the lower troposphere and tropical maritime (mT), warm and humid from the south and southeast in the upper troposphere.

CONCLUSIONS

The spring of 2020, although very early on average and excessively early in many areas of Oltenia was marked by 31 days with cold air advections in the first two months. These colds of the weather caused frosts and frost on the ground, in many mornings, with an extensive, local or isolated character that completely destroyed the flowers of the early fruit trees, especially almonds, apricots, peaches and crocodiles. Their start in the vegetation was excessively early in the first half of March, and the impact of the cooling of the weather was maximum. Although the average spring was warm (due to the accumulation of monthly temperature deviations), significant climatic anomalies occurred in the first two months of spring. The episode of late spring snow, as well as the intense cooling and snow cover, can be considered as *a late winter* after the flowering of early fruit trees. The intense drought of April, as well as the low temperatures in the air and soil, delayed the emergence of spring crops and caused significant damage through crop losses. We note that *the evolution of fig crops* (from Mehedinți County) was very good due to the warm Mediterranean winter. Subsequently, during the summer and the first part of autumn, the drought intensified and generalized, as in 2007, affecting all types of crops and increasing the damage caused. Warm winters and early spring are climatic anomalies, as later cold air from the polar areas is directed south and there is significant damage to agriculture.

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