

CLIMATIC ANOMALIES IN THE SPRING OF 2017 IN OLTENIA

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Abstract. The year 2015, according to the global average, was the warmest year since the beginning of the measurements and coincided with the maximum phase of the El Nino climatic process that extended until May 2016 (NOAA and WMO documents). A period of normality for the Southern Oscillation followed. In 2015, the global average air temperature exceeded the global average from the pre-industrial age for the first time by 1.0°C. Global warming continued, and 2016 was the warmest year in the history of the planet, exceeding the global average by 1.1°C. In Oltenia, the winter 2016-2017 was normal, with a general average of -1.4°C for the area with altitudes below 600 m, although December 2016 was also thermally normal. The winter was marked by a normal thermally and droughty December and a cold January, with the average for the entire region of -5.07°C, being the fifth coldest January of the last 57 years. In February, the weather continuously warmed up, from February 2nd, the period February 21-28 registering moderate heat wave. The coming of spring was very early, with an average coming of spring index for 2017 of 464.4°C, being the third index in descending order after 2016 (520.3°C) and 2002 (499.4°C). Although solar activity has been kept to a minimum, warming has continued, and March has been warm, April and May with a normal thermal value at the regional level. The vegetation started its development early, and the cold weather and late spring hoarfrost occurred in March (27-28.III) and April (21-24.IV), which caused significant damage to agricultural crops, vegetables and solariums. In some parts of the country, snow has fallen into certain periods. **Early coming of spring, and intense and late spring colds are climatic anomalies with destructive potential as in the present case.**

Key word: *early coming of spring, late spring hoarfrost, climatic risks, Oltenia.*

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1. INTRODUCTION

The year 2015 was the warmest year since the beginning of the measurements, coinciding with the maximum phase of the El Niño climatic process that extended until May 2016 (NOAA and WMO documents). The last El Niño ended in May 2016 and was the most intense since the 1997-1998 record event (<https://wattsupwiththat.com/2017/06/22/el-nino-watch-cancelled-enso-neutral-likely-for-2017>). In 2015, the global average air temperature exceeded the global average of the pre-industrial age for the first time by 1.0°C. Global warming continued, and 2016 was the warmest year in the history of the planet, exceeding the global average by 1.1°C. In Oltenia, the winter of 2016-2017 was thermally normal, with a general average of -1.4°C for the areas with altitudes below 600 m. The winter was marked by December (thermally normal and droughty) and January, a cold month with the average for the entire region of -5.07°C, being the fifth coldest January of the last 57 years. In February, the weather was getting continuously warmer from February 2nd, and a moderate heat wave was recorded in the period February, 21-28. **The coming of spring was very early**, with an average coming of spring index for the entire Oltenia region of 464.4°C, being the third index highest index after 2016 (520.3°C) and 2002 (499.4°C). Although solar activity has been kept to a minimum, warming continued, and March was warm, and April and May thermally normal at regional level.

Globally, in recent years there has been a slowdown of global warming, mainly due to the decline in solar activity. New data published by NASA and NOAA (7.IV.2017) showed that in 2017, March was the second hottest month in history after March 2016. The average temperature of the Earth's global surface was 1.12°C (or 2.016°F), higher than the 1951-1980 average. The two top temperature abnormalities in March have occurred over the past two years. March 2017 was just the eighth month in the NASA database with a global temperature anomaly of over 1°C (or 1.8°F) (<http://mashable.com/2017/04/14/march-second-warmest-month-climate-change/#eTyMl410hZq0>). On 19.III.2017, the Peru rainfalls that caused the catastrophic floods were more intense than those from the El Niño period and were a sign that El Niño might be coming back. The water temperature in the Equatorial Pacific (especially in the Niño area 1+2 and 3) has continuously increased during the spring months, which has developed a **positive temperature anomaly**.

As a result, the phenological observations in **March in Oltenia highlighted the following**:

- on 4.III.2017, the willow buds and the lilac sprouts opened and began to blossom.

- on 5.III.2017, the white magnolia (the earliest magnolia) blossomed and the "little rainstorm" (a shrub with shining yellow - "solar" yellow little flowers) began to bloom, with sprouts of ligustru (dogwood).
- on 5.III.2017, the bears that came out of hibernation caused damage to the ski slopes from Poiana Braşov and Postăvaru (Romania TV).
- on 18.III.2017, the apricot and the cherry plum began to flourish, then the vegetation "explosively" and generalized started, so that the environment changed rapidly.

The climatic anomalies in March appeared on the 27th of June 2017, when the hoarfrost spread over extensive areas, coinciding with a vegetation that started developing, as well for the apricots, the cherry plums, the cherry trees etc., and on 28.III.2017, the hoarfrost had a local character in the northern half of the region. In vineyards and orchards there were lit fires for raising the air temperature.

April 2017, the temperature was normal in Oltenia, with important climatic anomalies occurring in many areas of Romania, as follows: on 7.IV.2017 it **snowed** in Ardeal and Moldova (at Poiana Stampei, Suceava County, Tihuta Pass, etc.). A snow layer map was posted on the ANM site, where snow layer and snow thickness and curves reappeared. On 17.IV.2017, on the second day of Easter, it **snowed** in Buzău County, at Predeal, in the mountain area and, generally between 17-19th of April, the **snowfall** continued, followed by **late spring hoarfrost**, particularly destructive on the 21, 22, 23th of April. In the nights with hoarfrost from March and April, in the vineyards and orchards were lit fires for raising the air temperature.

Globally, on 12.IV.2017 **the first heat wave of 2017** was reported, when India recorded peak temperatures between 31 and 43°C (43.0°C at Nagpur), forecasting a warm summer, fact confirmed by the first summer heat wave of the 2017 in Romania, between 21.VI-1.VII.2017, followed at a short interval by a second one.

We will continue to analyze the climatic aspects of the spring of 2017 in Oltenia. The paper is part of a series of extensive studies on climate change in Oltenia and on climate change, being useful to all those interested in climate changes and their consequences (Bogdan, Octavia, Marinică I, Mic, Loredana-Elena, 2008; Bogdan, Octavia, Marinică, I., 2009; Bogdan, Octavia, Marinică I, Marinică, Andreea Floriana, 2010; Marinică, I., Marinică, Andreea Floriana, 2016).

2. DATA AND METHODS

For this paper were used the synoptic maps available on the internet from the international weather forecasting centres, the ANM site, the satellite information, as well as the information published in the print media.

3. RESULTS AND DISCUSSIONS

3.1. Climatic characteristics of March 2017

3.1.1 Thermal regime of March 2017

Monthly air temperature averages were between 6.3°C at Voineasa and 10.8°C at Dr. Tr. Severin, and their positive deviations from multiannual averages were between 3.9°C at Voineasa and 5.2°C in Drăgășani, including Oltenia in the thermal type of **warm month (W)** in most of the region, and in very restricted areas, in Drăgășani and Polovragi, very warm (VW) (Table 1).

Table 1. Air temperature regime in Oltenia and minimum and maximum temperature at ground level in March 2017, for the area with altitude ≤ 600 m: *N* = normal March, (1901-1990); *M* = temperature average of March 2017, Δ = *M*-*N* temperature deviation from normal (°C); *CH* = Hellmann criterion)

Meteorological station	Hm	N	M	Δ	CH	Tmin air		Tmax air		Tmin soil		Tmax soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr. Tr. Severin	77	5.9	10.8	4.9	W	0.3	27	24.8	30	-4.4	27	47.0	30
Calafat	66	5.6	10.5	4.9	W	-0.8	27	25.7	30	-0.6	4	31.5	30
Bechet	65	5.4	9.7	4.3	W	-3.0	27	23.4	30	-1.4	27	28.2	29
Bailești	56	5.4	9.6	4.2	W	-0.1	28	24.3	30	-0.2	28	32.6	30
Caracal	112	4.9	9.4	4.5	W	-0.2	27	23.0	29	-1.3	4	30.7	21
Craiova	190	5.1	9.4	4.3	W	-0.6	27	23.2	29	-1.0	27	40.6	29
Slatina	165	5.0	9.4	4.4	W	-2.5	27	23.4	29	-1.1	27	31.2	29
Băcleș	309	4.5	9.3	4.8	W	0.9	27	22.4	30				
Tg. Logrești	262	3.6	8.3	4.7	W	-3.5	27	23.0	24	-5.0	27	45.0	30
Drăgășani	280	4.7	9.9	5.2	VW	-0.4	27	23.9	24	-0.4	15	31.6	29
Apa Neagră	250	4.2	7.8	3.6	W	-4.5	4	24.0	24	-1.8	4	29.7	30
Tg. Jiu	210	4.8	9.6	4.8	W	-1.2	4	24.0	24	-2.0	4	43.1	30
Polovragi	546	3.0	8.2	5.2	VW	-1.6	27	21.8	22	-3.4	20	37.1	29
Rm. Vâlcea	243	5.0	9.8	4.8	W	-1.6	27	23.9	24	-3.4	27	40.6	29
Voineasa	587	2.4	6.3	3.9	W	-5.0	27	23.3	23				
Parâng	1585					-7.0	27	15.1	24				
Media Oltenia	-	4.6	9.2	4.6	W	-1.9		23.1		-1.9		34.8	
Ob. Lotrului	1404	-2.4	1.1	3.5	W	-10.3	27	16.4	23				
Petroșani	607	2.9				-5.5	27	23.6	24	-7.5	27	25.0	21

(Source: data processed from the ANM archive)

The monthly average air temperature, calculated for the whole region, was of 9.2°C, and its positive deviation from normal was 4.6°C, confirming that March, on average, was warm throughout the Oltenia region. The increase in the average air temperature compared to February was of 4.9°C, **the first significant increase in the monthly average air temperature during the year**. The rapid rise in air temperature in spring on the European continent was due to strong winds advection from two main directions: **from south**, with North African or Mediterranean air masses origins; and **from west**, with warm air masses above the Atlantic Ocean, driven by the Golf Stream, whose warm surface favours tropical warm air advections towards the British Isles, so the weather is often warmed up in the case of Northwest movements. This synoptic macro-process determines rapid

coming of spring, and the strong weather warming creates the impression that "the spring has disappeared and directly begins the summer". This massive hot air transport towards Europe in the spring months has been triggered since February and "catches the continent like a pliers", bringing early springs, a macro-process that has intensified due to climate warming. The thermal equator of the planet is migrating northwards, forcing the warming of the weather.

Maximum monthly air temperatures were recorded in March, the 22, 23, 24, 29 and 30, and ranged from 21.8°C at Polovragi and 25.7°C at Calafat, their average for the whole region being of 23.1°C (Table 1).

Monthly minimum air temperatures were recorded on March, the 27, and were between -5.0°C at Voineasa and 0.9°C at Băcleș (87.5% of them being negative), and their average for the entire region was -1.9°C. **This cooling of the weather between the 27-28th of March was the most intense from March.** Weather cooling occurs regularly every year, during the last part of the second decade, around the day of 23rd, and in other years even in the last pentacle of the month (as it was in 2017). **This cooling is a climatic anomaly** because it occurs after the spring equinox when the Earth has already crossed the celestial equator and is situated in the Northern Hemisphere; the increase of day duration by 3-4 minutes a day⁴ being the highest increases throughout the year; the day duration on March, the 27th is of 12 hours and 31 minutes, and on March, the 31st, 12 hours and 43 minutes, approaching the average duration for April (13 hours). **On the morning of March, the 27th there appeared hoarfrost on extended areas, and on the morning of March, the 28th the hoarfrost had a local character.**

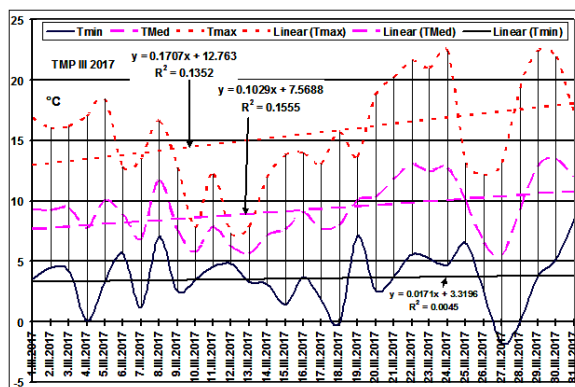


Figure 1. Variation of average temperatures for the entire Oltenia region, and of the minimum, average and maximum daily temperatures in March 2017 (Source: data processed after ANM Archive).

⁴ The analysis shows that, at the 45° latitude there is no 5 minutes increase of day duration from a day to another, and also no decrease of such order, causing a gradual weather warming, or a gradual weather cooling after the autumn equinox.

Consequently, we conclude that **in March an important climatic anomaly (the climatic anomaly of March, Fig. 1) occurs regularly**, which, in conditions of climatic warming, with warm winters and early coming of spring, has become more and more destructive for vegetation. Note that this intense cooling has affected much of European continent. In Romania there were affected **the vegetable crops in the solariums** (some were totally destroyed), **the orchards** (for the most part, the trees were blooming and the fruit were formed), **the vineyards and even the agricultural crops**. In order to combat its effects, there were fires lit in vineyards and orchards.

At the soil surface, the minimum temperatures were recorded on March, the 4, 15, 20, 27 and 28th, the most and the lowest being recorded on June, the 27th. These ranged from -5.0°C at Tg. Logresti (March, the 27th) and 0.4°C at Drăgășani (March, the 15th) and their average for the whole region was -1.9°C equal to the air temperature (Table 1).

Soil surface maximum temperatures were recorded, mostly on March, the 29th and 30th, with values between 29.1°C at Apa Neagră in the Subcarpathian Depression Area and 47.0°C at Dr. Tr. Severin in the extreme western region, and their average for the entire region was 34.8°C. *The parameters variation*, that characterize the air temperature, was rapidly increasing, and the highest increase had the maximum values (Fig. 1). The chart highlights the intense cooling of the weather in the period March, the 27-28th, when the overall average of the monthly air minimum temperature reached -1.9°C, being equal to the minimum temperature at the soil surface.

3.1.2 Pluviometric regime for March 2017

The atmospheric drought during the winter of 2016-2017 has been prolonged in the first month of spring (Table 2).

Monthly rainfall values in March ranged between 7.7 mm at Polovragi and 47.5 mm at Calafat; their normal deviations (N) ranged from -84.9% at Polovragi in the Subcarpathian Depression Area and 27.5% at Caracal, determining the extremely dry pluviometric type (ED) in some areas of the Oltenia Hills, extremely rainy to rainy in the Oltenia Plain (Calafat, Bechet and Caracal) (Table 2).

The average rainfall values for the entire Oltenia were of 26.7 mm and the deviation from normal of -36.4%, which shows that March was on average very dry (VD), being the fourth consecutive very dry, after December 2016, January 2017 and February 2017, which meant another negative weather anomaly, but with negative rainfall in March.

As a result of the prolonged atmospheric drought registered from the end of November 2016, until March 2017, the moisture content from **the winter wheat crop**, contained in the soil profile of 0-100 cm was within low limits (moderate pedological drought) and particularly low (strong pedological drought), on extended areas of Oltenia. The water soil supply shows satisfactory values isolated

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in southern Oltenia. In the soil layer of 0-20 cm (crop field), the water content was in low limits (moderate pedological drought) and particularly low (strong pedological drought) in most of Oltenia.

Table 2. Rainfall quantities registered in the spring of 2017(Σ), compared with the normal values (N) for the period 1901-1990, deviation ($\Delta\%$) and types of pluviometric regime according to Hellmann Criterion (CH).

Meteorological Station	Hm	March 2017				April 2017			
		Σ -III	N	$\Delta\%$	CH	Σ -IV	N	$\Delta\%$	CH
Dr. Tr. Severin	77	15.5	49.3	-68.6	ED	74.8	56.5	32.4	VR
Calafat	66	47.5	38.1	24.7	R	52.8	47.3	11.6	SR
Bechet	65	44.4	36.3	22.3	R	40.2	48.6	-17.3	SD
Băilești	56	36.8	38.3	-3.9	N	42.4	49.4	-14.2	SD
Caracal	112	45.5	35.7	27.5	R	34.2	45.1	-24.2	D
Craiova	190	32.0	31.5	1.6	N	57.4	43.1	33.2	VR
Slatina	165	43.3	37.5	15.5	SR	48.9	47.4	3.2	N
Tg. Logrești	262	20.5	37.9	-45.9	VD	58.2	49.9	16.6	SR
Drăgășani	280	11.7	37.4	-68.7	ED	62.4	40.1	55.6	ER
Apa Neagră	250	20.4	63.6	-67.9	ED	91.1	76.4	19.2	SR
Tg. Jiu	210	12.5	43.8	-71.5	ED	61.0	64.0	-4.7	N
Polovragi	546	7.7	50.9	-84.9	ED	55.6	70.4	-21.0	D
Rm. Vâlcea	243	12.6	36.8	-65.8	ED	81.4	58.5	39.1	VR
Parâng	1585	52.3	53.0	-1.3	N	102.2	86.3	18.4	SR
Media Oltenia		26.7	41.9	-36.4	VD	61.6	55.9	1.1	N
Ob. Lotrului	1404	44.5				90.5			
Stația Meteorologică	Hm	May 2017				Spring 2017			
		Σ -V	N	$\Delta\%$	CH	Σ -P	N	$\Delta\%$	CH
Dr. Tr. Severin	77	44.8	80.7	-44.5	VD	135.1	186.5	-27.6	VD
Calafat	66	82.2	60.8	35.2	VR	182.5	146.2	24.8	R
Bechet	65	63.6	58.6	8.5	N	148.2	143.5	3.3	N
Băilești	56	38.2	70.1	-45.5	VD	117.4	157.8	-25.6	D
Caracal	112	54.6	61.4	-11.1	SD	134.3	142.2	-5.6	N
Craiova	190	58.6	60.6	-3.3	N	148.0	135.2	9.5	SR
Slatina	165	50.7	64.8	-21.8	D	142.9	149.7	-4.5	N
Tg. Logrești	262	135.2	73.4	84.2	ER	213.9	161.2	32.7	VR
Drăgășani	280	131.4	69.7	88.5	ER	205.5	147.2	39.6	VR
Apa Neagră	250	80.8	108.8	-25.7	D	192.3	248.8	-22.7	D
Tg. Jiu	210	104.2	85.3	22.2	P	177.7	193.1	-8.0	N
Polovragi	546	169.0	103.9	62.7	ER	232.3	225.2	3.2	N
Rm. Vâlcea	243	170.0	97.3	74.7	ER	264.0	192.6	37.1	VR
Parâng	1585	154.3	114.8	34.4	VR	308.8	254.1	21.5	R
Average in Oltenia		94.7	80.0	18.3	P	185.9	177.4	4.8	N
Ob. Lotrului	1404	149.5				284.5			

(Source: data processed after ANM Archive)

3.2. Climatic characteristics of April 2017

3.2.1 Thermal regime of April 2017

Monthly average air temperatures ranged between 7.8°C in the Voineasa Inner-Carpathian Depression and 12.2°C in the extreme west of the region at Dr. Tr. Severin, and their deviations from normal were between -0.8°C at Polovragi and 0.3°C at Dr. Tr. Severin, determining a normal thermic type in the entire Oltenia (Table 3).

The monthly average air temperature calculated for the entire region was 10.7°C, with a deviation of -0.2°C, which confirms that April was a month normal thermic month. The increase of the general average air temperature compared to March was of 6.1°C, being **the first major increase in the monthly average air temperature during the year**⁵.

Monthly minimum air temperatures were recorded, in most cases, in April, the 22nd, and ranged between -4.1°C at Tg. Logrești and Voineasa, and 1.9°C at Calafat, their average for the entire region being -1.6°C. Monthly thermic minima were mostly negative (80.0%), and on the morning of April, the 22nd, there was hoarfrost on relatively large areas, more intense on the hills, in the Subcarpathians and in the mountains, where the temperatures were lower. Hoarfrost appeared also appeared in isolated areas on April, the 21, 24 and 25th (Table 3), affecting all agricultural crops, which were in the advanced vegetation stages. This intense climatic cooling, usually followed by hoarfrost, occurs frequently around the date of 23rd (coinciding with St. George's feast) and is **the second thermic anomaly of spring**.

Global warming has determined an increasingly severe anomaly, not just in Romania, but even in large areas of Europe or the Northern Hemisphere. The value of the damage caused by these late spring hoarfrosts is all the greater, the faster the coming of spring is.

Therefore, we conclude that **in spring two important thermic anomalies occur in an average period of one month** (between March, the 23th, and April, the 24th)⁶, which have become increasingly severe, especially due to the early coming of spring, especially due to climatic warming. In order to combat the hoarfrost, fires were lit in vineyards and orchards. The day's duration reaches 14 hours on the 26th of June, and 14 hours and 10 minutes on April, the 30th, already exceeding the general average of May⁷. **The maximum monthly temperatures** were recorded on April, the 28th and ranged between 24.4°C at Polovragi and 30.3°C at Bechet and their average for the entire region was 26.5°C (Table 3).

⁵ The analysis for Oltenia shows that there is no increase of general monthly average temperature from a month to another, of 7.0°C, and also no decrease of such size.

⁶ In folk tradition, the feast of St. George is the beginning of the warm season, which ends up with the feast of St. Demetrius.

⁷ In the calendar is shown that in May the day has 14 hours, and the night 10 hours.

The parameters' variations characterizing air temperature, as an evolution trend, were very slightly increasing, and the average daily values presented the fastest increase (Figure 2). It is highlighted the period April, 17-22, with a maximum cooling intensity on the morning of April, the 22.

Table 3. Air temperature regime in Oltenia and the minimum and maximum temperature values for soil surface in April 2017 for the areas with altitudes ≤ 600 m; N = normal for April (1901-1990), M = average temperature for April 2017; Δ ($^{\circ}\text{C}$) = $M - N$ = temperature deviation from the normal; CH = Hellmann Criterion

Meteorological Sation	Hm	N	M	Δ	CH	Tmin air		Tmax air		Tmin soil		Tmax soil	
						($^{\circ}\text{C}$)	Date	($^{\circ}\text{C}$)	Date	($^{\circ}\text{C}$)	Date	($^{\circ}\text{C}$)	Date
Dr. Tr. Severin	77	11.9	12.2	0.3	N	1.1	20	26.2	28	0.0	21	50.4	28
Calafat	66	11.8	11.9	0.1	N	1.9	22	26.7	28	0.6	22	31.4	28
Bechet	65	12.0	11.6	-0.4	N	0.2	25	30.3	28	0.9	22	40.8	15
Bailești	56	11.9	11.3	-0.6	N	0.0	24	26.9	28	0.9	22	29.8	2
Caracal	112	11.6	11.2	-0.4	N	-0.6	22	27.4	28	0.3	22	30.1	28
Craiova	190	11.5	10.9	-0.6	N	-1.2	22	26.3	28	-1.0	22, 23	44.0	27
Slatina	165	11.4	11.0	-0.4	N	-1.8	22	27.2	28	0.9	22	30.4	28
Băceș	309	10.2	10.4	0.2	N	-1.1	21	24.7	28	-	-	-	-
Tg. Logrești	262	10.3	9.9	-0.4	N	-4.1	22	26.8	28	-4.0	22	47.2	28
Drăgășani	280	10.9	11.1	0.2	N	-1.5	22	26.2	28	0.3	22	33.7	28
Apa Neagră	250	10.1	9.8	-0.3	N	-3.1	22	24.7	27	-2.7	22	27.7	28
Tg. Jiu	210	10.9	11.1	0.1	N	-3.2	22	26.0	28	-3.5	22	47.2	28
Polovragi	546	10.4	9.6	-0.8	N	-3.3	22	24.4	28	-4.4	24	43.8	27
Rm. Vâlcea	243	10.8	11.1	0.2	N	-2.7	22	28.2	28	-3.7	22	47.7	27
Voineasa	587	7.7	7.8	0.1	N	-4.1	22	24.8	27	-	-	-	-
Media Oltenia	-	10.9	10.7	-0.2	N	-1.6	-	26.5	-	-1.2	-	38.8	-
Ob. Lotrului	1404	2.0	2.2	0.2	N	-10.4	22	18.3	27	-	-	-	-

(Source: data processed from the ANM Archive)

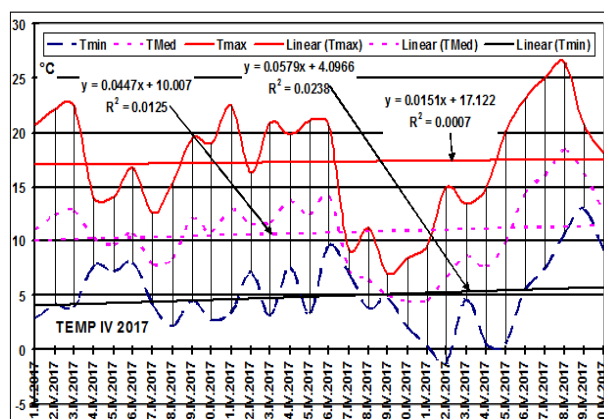


Figure 2. Average temperature variation for the entire Oltenia region, of minimum, average and maximum daily temperatures in April 2017 (Source: data analyse after ANM Archive).

At the soil surface, the monthly minimum temperatures were recorded mostly on April, the 22nd, ranging between -4.4 °C at Polovragi and 0.9 °C at Bechet, Băilești and Slatina, and their average for the entire region was -1.2 °C.

The maximum temperature at the soil surface was recorded mostly on the 27th and 28th of April, and ranged from 27.7 °C at Apa Neagră and 50.4 °C at Dr. Tr. Severin (Table 3).

3.2.2 The pluviometric regime of April 2017

The April rainfall quantities ranged from 34.2 mm at Caracal in the Romanați Plain and 91.1 mm at Apa Neagră, and their deviations from the normal values ranged from -24.2% at Caracal and 55.6% at Drăgășani, leading to classifications of the rainfall types from dry (D) in the Romanați Plain to extremely rainy (ER) at Drăgășani (Table 2).

The average rainfall quantities calculated for the entire region was 61.6 mm, and its deviation from normal, of 1.1%, showing, in general, a normal month (Table 2). In April, there was only one rainy interval, between the 16th and the 19th of April, and April, the 19th was the rainiest day, with an average for the entire region of 18.2 mm; only in the hilly area and the Subcarpathian depressions it slightly exceeded 30.0 mm. **April thus ended a period of 5 months with atmospheric drought (13.XI.2016-16.IV.2017)**, saving as much as possible the situation for agricultural crops in the advanced stage of development with important water requirements.

3.3. Climatic characteristics of May 2017

3.3.1 Thermal regime of May 2017

Monthly average air temperatures ranged between 13.0 °C at Voineasa and 17.9 °C at Dr. Tr. Severin, and their deviations from normal values ranged from -0.3 °C at Bechet and Băilești in the Oltenia Plain, and Slatina in Getic Piedmont, determining the normal thermic type (N) in the entire Oltenia except for a restricted area at Rm. Vâlcea where this month was warm (CL). The monthly average air temperatures calculated for the whole region was 16.3 °C, and the deviation from normal was 0.3 °C, indicating a normal thermic month for the entire Oltenia region (Table 4).

The increase of monthly average temperature compared to April was of 5.6 °C, **being the third and biggest increase throughout the year, but also the last high increase in the general average temperature**. Subsequently, the increases of general average temperature in Oltenia were lower and the last one appeared in July; during August appeared the first decrease.

Monthly minimum air temperatures were recorded in May, the 11th and were between 1.4 °C at Voineasa and 6.5 °C at Rm. Vâlcea, and their average for the entire region was 4.4 °C.

The intense and late cooling period in May is popularly called "*the days of the Ice Saints*"⁸, and after the old calendar, it ran from May 11 to May 15; after the calendar reform, it begins around May 23rd.

Table 4. Air temperature regime in Oltenia and minimum and maximum temperatures at soil surface in May 2017 for the area with altitudes ≤ 600 : *N* = temperature normal for May 2017(1901-1990); *M* = temperature average for May 2017; ΔT ($^{\circ}\text{C}$) = *M*-*N* = temperature deviation from the normal; *CH* = Hellmann Criterion)

Meteorological Station	Hm	N	M	ΔT	CH	Tmin air		Tmax air		Tmin soil		Tmax soil	
						($^{\circ}\text{C}$)	Date	($^{\circ}\text{C}$)	Date	($^{\circ}\text{C}$)	Date	($^{\circ}\text{C}$)	Date
Dr. Tr. Severin	77	17.1	17.9	0.8	N	6.2	11	32.2	31	6.1	11	63.4	20
Calafat	66	17.3	17.4	0.1	N	4.9	11	30.6	31	4.5	11	35.5	20
Bechet	65	17.5	17.2	-0.3	N	2.9	11	30.2	31	4.3	11	46.0	31
Bailești	56	17.4	17.1	-0.3	N	5.0	11	29.7	31	6.8	11	34.8	31
Caracal	112	17.1	17.0	-0.1	N	4.8	11	30.3	31	6.3	11	37.2	31
Craiova	190	17.0	16.8	-0.2	N	4.7	11	29.8	31	4.2	11	51.0	31
Slatina	165	16.9	16.6	-0.3	N	2.7	11	30.7	31	5.7	11	35.1	31
Băcleș	309	15.5	16.1	0.6	N	4.6	11	28.6	31				
Tg. Logrești	262	15.3	15.6	0.3	N	3.1	11	28.2	31	3.0	11	47.0	20
Drăgășani	280	15.8	16.3	0.5	N	6.1	11	28.7	31	6.8	11	38.3	4
Apa Neagră	250	15.1	15.8	0.7	N	4.9	11	28.7	31	6.0	11	33.2	31
Tg. Jiu	210	15.9	16.8	0.9	N	5.2	11	29.7	31	4.6	11	49.1	31
Polovragi	546	14.3	14.8	0.5	N	2.8	11	25.2	30	1.0	11	42.6	22
Rm. Vâlcea	243	15.4	16.5	1.1	CL	6.5	11	28.4	30	6.5	11	46.5	22
Voineasa	587	12.1	13.0	0.9	N	1.4	11	26.6	30				
Parâng	1585												
Media Oltenia	-	16.0	16.3	0.3	N	4.4		29.2		5.1	11	43.1	
Ob. Lotrului	1404	7.2	8.2	1	CL	-3.4	11	26.6	14				
Petroșani	607	12.3				1.1	11	26.1	31	1.9	11	27.7	31

(Source: data processed from ANM Archive)

Systematic observations have shown that the appearance date of cooling in May is quite variable, being possible even at the end of the month. In popular language it is said that *only after the "Sophie the Cold" passes the weather will stabilize and the spring will slowly - slowly, makes place for summer*. According to the statistical data, the most frequent cooling period is around 8 to 9 of May. It is still the last month of spring, but also the last month of the year when the thermic minima can drop below 0°C . As a result of the global climate warming

⁸ *The Ice Saints* are: *Mamarius* (May 11), *Pongrațius* (May 12), *Servațius* (May 13), *Bonifacius* (May 14), *Sophie* (May 15), and in May 25 is the day of *St. Urban* (according to the catholic and Calvinist calendar), the saint of vineyards, who can bring the last frost day of the year, especially in the northern part of Romania. The Ice Saints Days are characterized by **an accentuated weather cooling, abundant rainfalls and even ice on soil**, causing serious problems in agriculture. Only after the day of St. Sophie, the weather becomes much warmer. The tradition of Ice Saints is also found in the entire Central Europe, where such meteorological phenomena occurs.

phenomenon, can be observed an increase frequency of warmer months and a decreased one of colder months (Marinică, Andreea Floriana Marinică, 2016).

Thus, in May, there can be observed **a climatic anomaly (usually occurring between the 11 and 25 of May)**, consisting of a rather intense cooling in some years (Figure 3), which can bring the last late spring hoarfrosts. These such late hoarfrosts can be particularly severe although climatic warming has led to more and more attenuated cooling, but we cannot exclude such an intense phenomenon in the future. This is **the third and last spring climatic anomaly**, a negative thermic anomaly accompanied by very late hoarfrosts which, even when attenuated, lead to stagnation of the growing process and unfolding vegetation phases, with important effects in the field of vegetable growing.

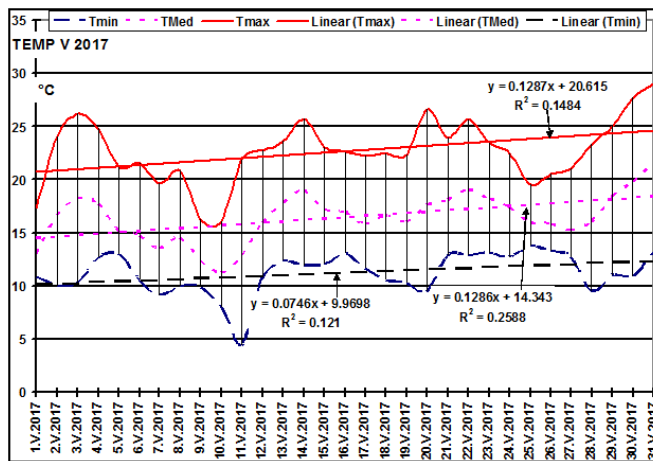


Figure 3. The variation of general average temperature in the entire Oltenia region, of minimum, average and maximum daily temperatures in May 2017 (Source: data processed from the ANM archive).

Due to the particular intensity of this climatic anomaly in the last decade of May, we present the climatic record of **the latest hoarfrost, recorded between May 21-22, 1952**, studied by Topor (1958), quoted by Bogdan and Niculescu (1999, p. 199) with index intensity of 2, destroying bean, corn, vines and fruit trees culture. During this cooling, the air temperature in the morning of 22.V.1952 dropped below 0°C, registering -1.6°C at Calafat, -1.5°C at Novaci, -1.2°C at Băilești and Caracal etc., some of these values have so far remained the absolute minimum of May for the respective localities (Marinică, I., Marinică, Andreea Floriana, 2016). The appearance frequency of extremely low intensities has diminished a lot due to climatic warming, but it cannot be said that the danger of this climatic anomaly has disappeared.

The monthly maximum air temperatures were mostly recorded on the last day of the month and were between 25.2°C at Polovragi and 32.2°C at Dr. Tr. Severin, their average for the whole region being 29.2°C (Table 4).

The parameters variations that characterize air temperature, as a trend of evolution, were rapidly increasing, and the fastest increase being for the daily maximum values, with a slope very close to that of the average (Figure 3). It is highlighted a cooling period during the 7-11, 20 and 28 of May, with maximum intensity on the morning of May, the 11th.

On the soil surface the temperature minima were recorded on the same morning as the air temperature minima on 11 of May and were between 1.0°C at Polovragi and 6.8°C at Băilești and Drăgășani, and their average for the entire region was 5.1°C (Table 4).

The maximum soil surface temperatures were recorded on May, the 31st and were between 33.2°C at Apa Neagră and 63.4°C at Dr. Tr. Severin, and their average for the entire region was 43.1°C (Table 4).

3.3.2 The pluviometric regime of May 2017

Monthly rainfall values ranged from 38.2 mm at Băilești on the Oltenia Plain and 170.0 mm at Rm. Vâlcea in the Olt River Corridor, and the percentage deviations from the normal values ranged between -45.5% at Băilești and 88.5% at Drăgășani, generating a pluviometric type ranging from very dry (VD) on restricted areas at Dr. Tr. Severin and Băilești, to extremely rainy (ER) at Tg. Logrești, Drăgășani, Polovragi and Rm. Vâlcea. Average precipitation values calculated for **the entire region** were of 94.7 mm with a percent deviation from normal of 18.3%, causing a slight rainy weather type (SR) on average. **There were recorded three intervals with significant rainfalls: 4-5, 7-9 and 24-27 of May**, summing up 9 rainy days, and among them the interval 4-5 of May, when there were recorded the greatest rainfall quantities, their averages for the entire region being 13.7 mm in the 4 of May and 17.1 mm on the 5 of May. The rainfalls during May have restored the water reserve in the northern half of the region.

3.4. Climatic ensemble features of the spring of 2017

3.4.1 The thermic regime for the spring of 2017

The average annual temperature values were between 9.0°C at Voineasa and 13.6°C at Dr. Tr. Severin, and their deviations from the normal values were between 1.1°C in Băilești and 2.0°C at Dr. Tr. Severin, Tg. Jiu and Rm. Vâlcea determining the type of warm spring throughout the Oltenia region (Table 5).

Table 5. Thermal and springtime total rainfall regime 2017: *Hm* = altitude of the weather station; *P* = average temperature values in spring 2017 (°C); *N* = normal values of springtime average temperatures (°C); $\Delta T = P - N$ = Average temperature deviations from normal (°C); ΣP = sum of precipitation in spring 2017 (l / m²); *NP* = normal rainfall values (l / m²); $\Delta = \Sigma P - N$ deviations from normal rainfall (l / m²), $\Delta p\%$ = percentage deviations from normal rainfall; *CH* = Hellmann criterion).

Meteorological Station	Hm	Thermic regime (°C)				Pluviometric regime (l/m ²)				
		N	P	Δ	CH	ΣP	N	Δ	$\Delta p\%$	CH
Dr. Tr. Severin	77	11.6	13.6	2.0	C	135.1	186.5	-51.4	-27.6	VD
Calafat	66	11.6	13.3	1.7	C	182.5	146.2	36.3	24.8	R
Bechet	65	11.6	12.8	1.2	C	148.2	143.5	4.7	3.3	N
Băilești	56	11.6	12.7	1.1	C	117.4	157.8	-40.4	-25.6	D
Caracal	112	11.2	12.5	1.3	C	134.3	142.2	-7.9	-5.6	N
Craiova	190	11.2	12.4	1.2	C	148.0	135.2	12.8	9.5	SR
Slatina	165	11.1	12.3	1.2	C	142.9	149.7	-6.8	-4.5	N
Băcleș ⁹	309	10.1	11.9	1.8	C	100.4	172.5	-72.1	-41.8	VD
Tg. Logrești	262	9.7	11.3	1.6	C	213.9	161.2	52.7	32.7	VR
Drăgășani	280	10.5	12.4	1.9	C	205.5	147.2	58.3	39.6	VR
Apa Neagră	250	9.8	11.1	1.3	C	192.3	248.8	-56.5	-22.7	D
Tg. Jiu	210	10.5	12.5	2.0	C	177.7	193.1	-15.4	-8.0	N
Polovragi	546	9.2	10.9	1.7	C	232.3	225.2	7.1	3.2	N
Rm. Vâlcea	243	10.4	12.4	2.0	C	264.0	192.6	71.4	37.1	VR
Voineasa	587	7.4	9.0	1.6	C	153.3	200.6	-47.3	-23.6	D
Parâng	1585				C	308.8	254.1	54.7	21.5	R
Media Oltenia		10.5	12.1	1.6	C	185.9	177.4	8.5	4.8	N
Ob. Lotrului	1404	2.3	3.8	1.5	C	284.5		284.5		
Petroșani	607	7.7				197.2	183.1	14.1	7.7	N

(Source: data processed from the ANM archive)

The average seasonal air temperature for the entire region was 12.1°C, with a 1.6°C deviation from normal, which confirms the warm spring feature.

3.4.2 The pluviometric seasonal regime for the spring of 2017

The annual rainfall values ranged between 117.4 mm at Băilești and 264.0 mm at Rm. Vâlcea, and their percentage deviations from the normal values ranged between -27.6% for Dr. Tr. Sevrin and 39.6% for Drăgășani, determining weather types that varied from very dry (VD) in the extreme west at Dr. Tr. Severin and dry (D) in the Băilești Plain and in the area of the Apa Neagră Subcarpathian Depression, to very rainy (VR) in the hilly area of Tg. Logrești and Drăgășani and in the Olt Valley at Rm. Vâlcea (Table 5).

The average annual value for the entire region was 185.9 mm and its percentage deviation from normal was 4.8%, indicating that, on average, the spring 2017 was normal from a pluviometric point of view, a characteristic determined by

⁹ For rainfalls, the Voineasa and Băcleș meteorological stations there are not taken into account the average values, because they are automat stations, with problems that concern data correctness. Data were introduced in the table only, as indication for some values.

the statistical mediation between extremely diverse quantities, varying from very dry, to extremely rainy.

4. CONCLUSIONS

In 2017, **the coming of spring was very early**, with an average index for the entire region of Oltenia of 464.4°C, being the third index value in descending order after 2016 (520.3°C) and 2002 (499.4°C), even though the solar activity has been kept to a minimum.

The spring of 2017 was a warm and pluviometric normal, a characteristic determined by the statistical mediation of extremely diverse quantities ranging from very dry to extremely rainy.

After analyzing the seasonal volumes, the atmospheric drought was recorded in the extreme western part of the region, in the Băilești Plain and in the Apa Neagră Subcarpathian Depression. The surplus rainfalls that caused a very rainy spring were recorded in the area of the Subcarpathian Hills at Tg. Logrești and Drăgășani and in the Olt River Valley at Rm. Vâlcea.

March was very dry and the rains occurred after 5 months of severe atmospheric drought registered between 13.XI.2016 - 16.IV.2017, during which several consecutive months were excessively dry or very dry. Only 4 rainy intervals were recorded: 16-19.IV, 4-5.V, 7-9.V and 24-27.V summing up only 13 rainy days (14.1% of the spring days).

The warm spring feature was determined mainly by **the warm March**, and April and May were normal thermal, although at the end of each, the temperature maxima were high (30.3°C at Bechet on the 28 of April (Table 3) and 32.2°C at Dr. Tr. Severin on the 31 of May (Table 4)), **with summer days in some areas appearing all the spring and tropical days in April and May**.

In spring, as a rule, there are three major climatic anomalies of thermal nature, consisting in a decrease of air temperatures below freezing point, causing severe climatic risks, such as late hoarfrosts that severely affect crops, fruit trees, vines and general vegetation.

These climatic anomalies of thermal nature occur at variable intervals but with frequent average occurrence data, in March around the 23, in April around the 23 and in May in the period 11-25.

Although winter **was normal from thermic point of view** (since December was a normal, January cold and February warm), there was a very early coming of spring, **a process that started from February, the 2nd**, when the last cold morning and the first warm day of February were registered.

The synoptic causes of these climatic anomalies of thermal nature are determined by the specific conditions of Romania's settling on the European continent, which causes the appearance of early coming of spring, and on the

Alpine-Carpathian mountain range as well as the presence of the Black Sea, frequently limiting the extension of the Azoric Anticyclone towards east, at the eastern limit of the Carpathians, which leads to the expansion of the Icelandic Cyclones up to the south of Romania, the formation of the North or North-eastern polar air circulation, the intense advection of cold polar continental air (cPk) from the Scandinavian Peninsula or from the north-eastern part of the continent and the production of intense late spring cooling, associated with frost, freezing in the air and hoarfrost.

Although climatic warming has continued, it has not eliminated these climatic risks, but on the contrary it has increased them due to the early start of vegetation and its appearance in advanced stages, which makes the vegetation particularly vulnerable, the destruction being significant. The translation of spring towards winter has become more common.

REFERENCES

1. Bogdan, Octavia, Niculescu, El. (1999), *Riscurile climatice din România*, Academia Română, Institutul de Geografie, București, 280 p.
2. Bogdan, Octavia, Marinică, I., Mic, Loredana-Elena, (2008). *Considerații asupra „fenomenului de iarnă caldă” din România*, Edit. Universității București, 12, pp. 139-144.
3. Bogdan, Octavia, Marinică, I. (2009), *Caracteristici climatice ale iernii 2007-2008 în Oltenia*, Revista Geografică, Serie Nouă, Edit. ARS DOCENDI, București, 16, pp. 73-81.
4. Bogdan Octavia, Marinică I., Marinică Andreea Floriana, 2010. *Frequency of warm winters within Oltenia in 1999-2008 decade*, Conferința ”Aerul și Apa. Componente ale Mediului”, 19-20.III.2010, Edit. Presa Universitară Clujeană, Cluj-Napoca, pp. 45-54.
5. Bogdan, Octavia, Marinică, I., Marinică, Andreea Floriana (2010), *Indexes of Spring arrival beetwin 2000 and 2010*, Forum geografic, Studii și cercetări de geografie și protecția mediului, 10, Issue 1 / June 2011, Craiova, pp. 129 – 139;
6. Marinică, I., Marinică, Andreea Floriana (2016), *Variabilitatea climatica în Oltenia și schimbări climatice*, Edit. Universitaria, Craiova, 308 p