

CLIMATIC ASPECTS OF THE SUMMER OF 2017 IN THE CONTEXT OF CLIMATIC CHANGES

I. MARINICĂ¹, ANDREEA FLORIANA MARINICĂ²

Abstract. Climatic aspects of the summer of 2017 in the context of climatic changes. Year 2017 was, at a global warming level, the third year in descending order of temperature averages. In Oltenia, as in the whole country, during the summer there were long dry and canicular periods. For the period 4-5.VIII.2017, a red and orange code of meteorological warning for the whole country was issued for high temperature and thermal discomfort, being the first such warning for the whole of Romania throughout the ANM's history. On August 3, 4 and 5, the thermal comfort index (ITU) exceeded the critical threshold of 80 across the country except for the mountain range. The maximum value of this parameter for the whole country was 86.3 at Brăila and in Oltenia 86.0 at Calafat on the 6th of June. The heat wave between July 29 and August 12 (15-day duration), with the peak on August 4, 5 and 6, is a new record for Romania. In Oltenia six absolute thermal records and four values of monthly thermal maxima were recorded, in the second place in descending order of the data strings. The paper is a continuation of extensive studies on climate variability and climatic conditions in southwest Romania (Marinica I, 2006; Marinica, Andreea, Floriana, Marinica 2016).

Keywords: *drought, heat, climatic risks, climate records.*

1. INTRODUCTORY REMARKS

Globally, the year 2015 was the warmest year since the beginning of the measurements, after the global average, and coincided with the maximum phase of the El Niño³ climatic process that extended until May 2016 (NOAA and WMO documents). In 2015, the global average air temperature exceeded the global average of the pre-industrial age for the first time by more than 1.0°C. The year 2016 followed with an overrun of more than 1°C. Year 2017 was the third consecutive year in which the global average temperature exceeded the global average of the pre-industrial age by more than 1.0°C, roughly equal to the one of 2016. Year 2017 is one of the three warmest years on our planet, with extreme

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³ El Niño is considered to be an intensification of the warm Pacific equatorial current and returns with a frequency of once every five years.

climatic events (the year of climatic extremes), according to the WMO interim climate statement and the ONU report (NASA Goddard Institute for Space Studies (GISS) in New York). The report also highlights the impact on human safety, well-being and the environment. The global thermal record of 2017 is important because it was achieved in the absence of the El Niño climatic process and during the minimum solar activity. The five-year period between 2013 and 2017 is considered the warmest period recorded, with an average temperature by 0.4°C warmer than the average of the 1981-2010 period. The World Meteorological Organization noted that the average global temperature during the period January to September 2017 was 1.1°C over the pre-industrial period.

On a regional level, in Oltenia, the hot weather started from the morning of February 2, 2017 when, from the frosty weather of January, the heating caused February to be a warm month. The summer of 2017 was excessively warm with long drought intervals and excessively high temperatures. The summer heat peaked at the beginning of August when absolute thermal peaks were reached and exceeded at many weather stations in the country, and in Oltenia there were five weather stations that recorded absolute temperature records. Drought is a particularly dangerous climatic risk and can cause major damage and even economic recession. The analysis of the climatic data for the period 1901-2017, shows that for Romania ***the hottest 17 years occurred in the period 2000-2017***⁴. The start of the spring of 2017 was among the earliest since the first measurements were made in Romania, and after the average of The start of the spring indices for the entire Oltenia region, it was fourth in decreasing order after 2016, 2002 and 2007. March 2017 as a whole was warm, but the hoarfrosts of the last decade have affected the vegetation and cultures that had begun to develop since the second decade of February. April 2017 presented a normal heat in its entirety, but intense hoars and frosts in the air and on the surface of the soil on April 21 and 22 did severely affect the vegetation and the cultures in advanced stages of development. At the end of November 2017, the measurement data prefigured the result that the year 2017 was expected to exceed the global thermal record of 2015. We will continue to analyze some climatic issues on the droughty summer 2017 in Oltenia.

2. DATA AND METHODS

For the realization of the paper were used synoptic maps existing on the Internet from the international forecasting centers, the ANM site, the satellite information as well as the information published in the written press.

⁴ ***The warmest 18 years in Romania*** in the period 1901-2017, in descending order of the annual average temperature, were: 2015, 2007, 2014, ***1994***, 2012, 2013, 2017, 2016, 2009, 2008, 2010, 2011, 2004, 2006, 2003, 2005. In this exceptional line, 1994 does not fall within the period 2000-2017.

3. RESULTS AND ASSESSMENTS

3.1. Characterization of the main climatic elements for the summer months of 2017

3.1.1 Air temperature and atmospheric precipitation characterization of June 2017

Air temperature. *Monthly average temperatures* were between 17.9°C at the southern boundary of the mountain range at Voineasa and 24.8°C in the extreme west of Oltenia, at Dr. Tr. Severin, and their deviations from the normals calculated for the period 1901-1990 were between 2.2°C in the Oltenia Plain at Bechet and Băilești, and 5.2°C in the area of the Sub-Carpathian depressions at Apa Neagră, leading to the classification of the types of thermal time at the meteorological stations, as **warm month** (W) with the exception of the Apa Neagră station where it was **excessively warm** (EW) (Table 1).

Table 1. Characteristic air temperature values at soil surface recorded at the meteorological stations from Oltenia in June 2017 ($\Delta=M-N$ = deviation from the normal of the average temperature in June, CH = Hellmann Criterion, NVI= temperature averages for July calculated for 1901-1990– normals; MVI = temperature averages for June 2017)

Meteorological Station	Hm	NVI	MVI	$\Delta=M-N$	CH	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr. Tr. Severin	77	20.7	24.8	4.1	W	38.7	29	13.5	10	67.3	30	12.2	19
Calafat	66	21.0	24.4	3.4	W	39.9	29	12.4	10	54.5	20	14.4	15
Bechet	65	21.3	23.5	2.2	W	39.7	29	11.9	16	53.9	30	12.4	4
Bailesti	56	21.1	23.3	2.2	W	39.4	29	11.3	13	46.2	29	12.5	15
Caracal	112	20.8	23.6	2.8	W	39.5	29	12.9	18	55.1	23	13.2	18
Craiova	190	20.6	23.5	2.9	W	38.8*	29	11.7	18	63.4	29	12.2	18
Slatina	165	20.5	23.0	2.5	W	38.9*	29	11.9	10	44.4	29	13.4	10
Bacles	309	19.0	22.6	3.6	W	36.7	29	9.8	18	-	-	-	-
Tg. Logresti	262	18.8	21.3	2.5	W	35.4	29	8.6	15	59.4	30	10.0	15
Dragasani	280	19.4	22.7	3.3	W	36.6	29	12.1	15	43.7	30	13.7	10
Apa Neagra	250	16.6	21.8	5.2	EW	35.3	29	6.5	15	47.7	22	10.0	15
Tg. Jiu	210	19.4	23.1	3.7	W	36.6	29	10.6	15	59.8	29	10.8	15
Polovragi	546	17.7	20.5	2.8	W	32.5	29	9.1	15	58.5	29	7.6	15
Rm. Valcea	243	19.0	22.1	3.1	W	35.4	29	11.4	15	62.4	24	10.0	2
Voineasa	587	15.3	17.9	2.6	C	32.5	30	6.5	10	-	-	-	-
Parang	1585	-	-	-	-	22.8	29	3.8	18	-	-	-	-
Average Oltenia	-	19.4	22.5	3.1	W	36.2		10.3		55.1		13.1	19
Ob. Lotrului	1404	10.8	13.3	2.5	C	25.4	29	1.8	10	-	-	-	-

Hm = altitude of the meteorological station, $\Delta=M-N$ = deviation from the normal of the average temperature in June, CH = Hellmann Criterion, NVI= temperature averages for June calculated for 1901-1990; MVI = temperature averages for June 2017 (EW= excessively warm, VW= very warm, W=warm, WS=warmish, N=normal) (Source: processed data from the ANM Archive)

The average air temperature calculated for the entire region was 22.5°C, and its deviation from normal was 2.5°C confirming that **June was a warm month (W)**.

The maximum monthly temperature values were recorded mostly on July 29 and were between 32.5°C at Polovragi and Voineasa, and 39.9°C at Calafat, signaling *the forward motion of the warm, tropical air up to the southern limit of the mountain area*, and their average for the whole region was 36.2°C. *The value of 38.8°C recorded in Craiova on June 29 is the absolute thermal minimum of June* and the value of 38.9°C recorded in the Getic Piedmont at Slatina on the same day is the highest temperature in the last 107 years, *the absolute thermic maxima for June*, the last maxima recorded at this meteorological station being 39.0°C in 1911. Thus, in June 2017 two thermal records were registered, of which one absolute.

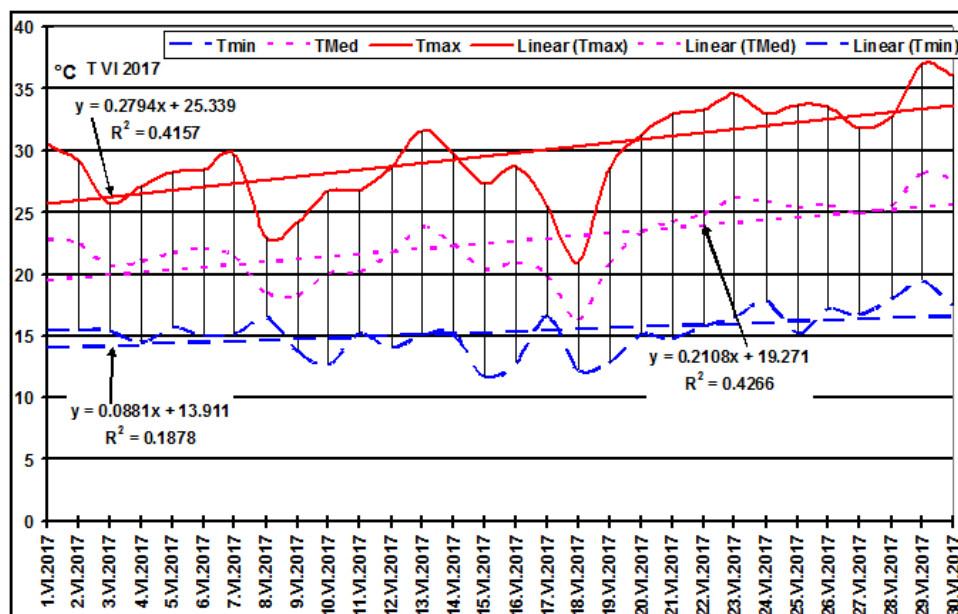


Fig. 1. Variation of average air temperatures, daily maxima, average and minima calculated for the entire Oltenia region in June 2017 (Source: processed data from the ANM Archive)

Most *monthly temperature minima* were recorded in the first half of the month and ranged between 6.5°C at Apa Neagră and Voineasa, and 13.5°C at Dr. Tr. Severin, and their average for the whole region was 10.3°C. *At the soil surface, the highest temperatures* were recorded mostly in the last decade, on June 29 and 30 and were between 43.7°C in Drăgășani and 67.3°C at Dr. Tr. Severin, being

comparable to those of July, and their average for the whole region was 55.1°C, slightly higher than in July. Temperature minima at soil surface were most recorded in the first half of the month and ranged between 7.6°C at Polovragi and 14.4°C in the extreme southwest at Calafat, and their average for the whole region was 13.1°C, higher than in July. Warming in June was slow since June 21, when daily thermal maxima exceeded 33.0°C. This first long-lasting heat wave (June 21 – July 2, 11 days) had two peak days: one on June 29, when were reached most of the peaks of June, and the other date was the 1st of July, when most of July's monthly maxima were reached. For the period June 30 – the 2nd of July was issued a red code for high temperatures for more than half country. As a result of the warm weather and intense drought on a large part of Europe, the Danube level at Bechet decreased on the 1st of July by 6 cm compared to the previous day, as a result the Bechet-Oreahovo ferry only circulated during the day (07-21 hours). *The variation graphs for the air temperature parameters in June (daily maxima, daily averages and daily minima) had increasing linear trends, and the daily maxima had the fastest growth, with a growing rate of 0.2794 (Fig. 1).*

Atmospheric rainfalls. *The monthly rainfall values* ranged between 2.2 l/m² in Craiova and 77.5 l/m² in Voineasa, and their percentage deviations from multiannual averages were between -96.9% in Craiova and -18.1% at Rm. Vâlcea, according to Hellmann Criterion, *an excessively droughty month (ED) in most of the region except for a restricted area in the north of Vâlcea county at Rm. Vâlcea, where it was droughty (D) and Voineasa where it was little droughty (LD).* Daily rainfall averages were insignificant (generally less than 2 l/m²). As a result of the atmospheric drought on June 30 in most part of Oltenia, the soil water reserve in agricultural crops was particularly low, and the severe (SD) and moderate (MD) drought dominated, with the exception of the northern region where the calculation models of the water reserve indicated an almost satisfactory reserve (AS).

3.1.2 Air temperature and rainfall characterization of July 2017

Air temperature. *Monthly temperature averages* ranged between 20.9°C at Polovragi and 25.9°C at Dr. Tr. Severin and their deviations from the multiannual averages calculated for the period 1901-1990 were between 0.7°C at Tg. Logrești in the hill area and 2.8°C at Dr. Tr. Severin, designating according to Hellmann Criterion a **warm month** (WS) in most of the region, except for two restricted areas (Tg. Logrești and Voineasa) where it was normal (Table 2).

The average air temperature calculated for the whole region was 23.0°C, and its deviation from the average was 1.5°C, confirming the **warm month** (WS) classification on almost the entire region. *Monthly maximum air temperatures* were recorded the most on July the 1st and ranged between 32.5°C at Polovragi and 39.1°C at Caracal, slightly lower than those of June, and their average for the entire region was 35.8°C.

Table 2. Characteristic air temperature values at soil surface recorded at the meteorological stations from Oltenia in July 2017 ($\Delta=M-N$ = deviation from the normal of the average temperature in July, CH = Hellmann Criterion, NVII= temperature averages for July calculated for 1901-1990– normals; MVII = temperature averages for July 2017)

Meteorological Station	Hm	NVII	MVII	$\Delta=M-N$	CH	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Date	(°C)	Date	(°C)	Date	(°C)	Date
Dr. Tr. Severin	77	23.0	25.8	2.8	W	38.4	22	13.1	17	66.6	11	11.0	5
Calafat	66	23.2	25.0	1.8	WS	38.7	22	14.4	18	48.9	24	14.5	5
Bechet	65	23.0	24.5	1.5	WS	37.8	1	12.7	30	51.5	30	13.7	5
Băilești	56	22.8	24.2	1.4	WS	37.7	1	12.6	5	46.4	23	13.8	5
Caracal	112	22.9	24.2	1.3	WS	39.1	1	14.4	5	44.7	11	14.9	5
Craiova	190	22.3	24.2	1.9	WS	38.9	1	13.5	5	63.4	22	14.0	17
Slatina	165	22.0	23.6	1.6	WS	38.2	1	12.2	5	43.0	1	13.5	5
Băcleș	309	21.3	23.1	1.8	WS	35.7	11	12.7	27	-	-	-	-
Tg. Logrești	262	20.7	21.4	0.7	N	34.8	1	9.6	5	55.6	11	11.5	14
Drăgășani	280	21.7	23.2	1.5	WS	36.4	1	13.2	5	41.5	1	14.1	5
Apa Neagră	250	20.5	21.9	1.4	WS	34.7	22	8.2	14	48.0	11	10.9	5
Tg. Jiu	210	21.3	22.9	1.6	WS	35.7	1	11.5	27	57.2	10	11.0	27
Polovragi	546	19.7	20.9	1.2	WS	32.5	1	10.7	14	54.7	13	9.1	14
Rm. Vâlcea	243	21.2	22.4	1.2	WS	36.2	1	12.3	5	60.1	10	12.0	28
Voineasa	587	17.1	17.9	0.8	N	33.0	1	8.1	5	-	-	-	-
Parâng	1585	-	-	-	-	24.5	22	-	-	-	-	-	-
Average Oltenia		21.5	23.0	1.5	WS	35.8		11.9		52.4		12.6	
Ob. Lotrului	1404	12.5	13.5	1	WS	26.7	11	2.9	18	-	-	-	-
PETROȘANI	607	17.4	-	-	-	31.5	22	7.5	5	44.2	7	5.8	22

Hm = altitude of the meteorological station, $\Delta=M-N$ = deviation from the normal of the average temperature in July, CH = Hellmann Criterion, NVII= temperature averages for June calculated for 1901-1990; MVII = temperature averages for July 2017 (EW= excessively warm, VW= very warm, W=warm, WS=warmish, N=normal) Source: processed data from the ANM Archive

Monthly air temperature minima were recorded the most in July 5 and were between 8.1°C at Voineasa and 14.4°C at Calafat and Caracal. An interesting feature of the weather warming in July 2017 is that after the cooling from July 3 and 6, due to the most intense rain in this summer recorded from the afternoon of the 2nd of July to the 3rd of July, the warm weather returned from July 7 to 12 (*the second summer heat wave of 2017, lasting 6 days*).

The third heat wave was recorded between July 20 to 24, and *the forth heat wave* between July 29 and August 12 (with a duration of 15 days). At soil surface, the monthly maximum temperatures were recorded at different dates, ranging from 41.5°C at Drăgășani and 66.6°C at Dr. Tr. Severin, being slightly lower than in June, and their average for the whole region was 52.4°C. Soil temperature minima were most recorded on July 5th and were between 9.1°C at Polovragi and 14.9°C at Caracal, with an region average of 5.8°C, lower than the one for June.

The parameter charts of the air temperature characteristics in July (daily maxima, daily averages and daily minima calculated for the entire Oltenia region)

show a slightly increasing linear trend only for the daily average maxima and a slightly decreasing trend for daily average minima (Fig. 2).

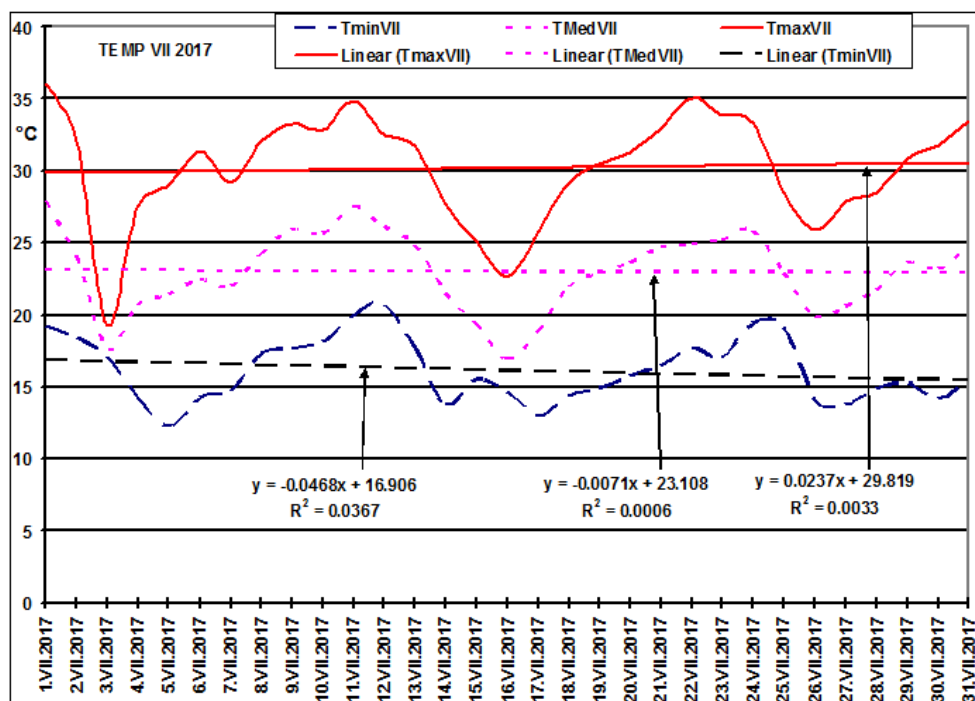


Fig. 2. Variation of average air temperatures, daily maxima, average and minima calculated for the entire Oltenia region in July 2017 (Source: processed data from the ANM Archive)

Atmospheric rainfalls. *Monthly rainfall quantities in July* ranged from 27.4 l/m² to Dr. Tr. Severin and 172.6 l/m² in Polovragi, and the percentage deviations from multiannual averages were between -44.4% at Dr. Tr. Severin and 139.5% at Bechet, according to Hellmann Criterion, *an excessively rainy month in most of Oltenia*, with the exception of a restricted area in the extreme western and south-western part of the region (Dr. Tr. Severin and Calafat) where it was very droughty (VD) and droughty (D) respectively (Table 3). The low rainfall period have installed starting with the 4th of July and maintained until September 18th. The rains were due to a strong and fast Mediterranean Cyclone that affected southern Romania on dates 2 and 3 of July. On the other days, the overwhelmingly mild rainfall, isolated for agriculture in the hills, was due to weak Black Sea cyclones, or to some Icelandic Cyclones, which caused some cool and wet air advections to Oltenia.

Table 3. Monthly and seasonal rainfall quantities (mm) recorded in the summer of 2017 (Σ), compared with the normal values (N for the period 1901-1990), deviation ($\Delta\%$) and type of pluviometric time according to Hellmann Criterion (CH)

Meteorological Station	Hm	June 2017				July 2017			
		ΣVI	N	$\Delta\%$	CH	ΣVII	N	$\Delta\%$	CH
Dr. Tr. Severin	77	3.4	72.5	-95.3	ED	27.4	49.3	-44.4	VD
Calafat	66	4.0	65.6	-93.9	ED	40.6	45.6	-11.0	LD
Bechet	65	23.8	62.3	-61.8	ED	111.6	46.6	139.5	ER
Băilești	56	6.3	66.5	-90.5	ED	53.1	45.0	18.0	LR
Caracal	112	12.6	73.7	-82.9	ED	88.2	53.8	63.9	ER
Craiova	190	2.2	71.2	-96.9	ED	84.2	51.4	63.8	ER
Slatina	165	29.8	80.6	-63.0	ED	102.4	57.5	78.1	ER
Băcleș	309	9.8	72.0	-86.4	ED	72.4	47.1	53.7	ER
Tg. Logrești	262	24.2	72.3	-66.5	ED	115.6	49.5	133.5	ER
Drăgășani	280	13.8	87.6	-84.2	ED	110.4	51.6	114.0	ER
Apa Neagră	250	4.2	99.2	-95.8	ED	87.4	72.7	20.2	R
Tg. Jiu	210	13.6	93.0	-85.4	ED	137.2	61.9	121.6	ER
Polovragi	546	38.8	112.3	-65.4	ED	172.6	88.9	94.2	ER
Rm. Vâlcea	243	71.2	86.9	-18.1	LD	133.0	98.0	35.7	VR
Voineasa	587	77.5	106.7	-27.4	D	164.5	88.6	85.7	ER
Parâng	1585	67.8	124.1	-45.4	VD	95.8	132.1	-27.5	D
Average Oltenia	-	25.2	84.2	-70.1	ED	99.8	65	53.6	ER
Ob. Lotrului	1404	46.0				135.0			
Meteorological Station	Hm	August 2017				Summer (S) 2017			
		$\Sigma VIII$	N	$\Delta\%$	CH	ΣS	N	$\Delta\%$	CH
Dr. Tr. Severin	77	35.2	38.2	-7.9	N	66.0	160.0	-58.8	ED
Calafat	66	44.6	35.6	25.3	R	89.2	146.8	-39.2	VD
Bechet	65	18.4	37.9	-51.5	ED	153.8	146.8	4.8	N
Băilești	56	41.4	39.0	6.2	N	100.8	150.5	-33.0	VD
Caracal	112	5.0	39.9	-87.5	ED	105.8	167.4	-36.8	VD
Craiova	190	10.2	42.1	-76.2	ED	96.6	164.7	-41.3	VD
Slatina	165	16.6	46.8	-64.5	ED	148.8	184.9	-19.5	D
Băcleș	309	38.7	33.4	15.9	LR	120.9	152.5	-20.7	D
Tg. Logrești	262	18.4	43.6	-57.8	ED	158.2	165.4	-4.4	N
Drăgășani	280	24.8	46.4	-46.6	VD	149.0	185.6	-19.7	D
Apa Neagră	250	13.2	60.1	-78.0	ED	104.8	232.0	-54.8	ED
Tg. Jiu	210	7.4	64.3	-88.5	ED	158.2	219.2	-27.8	VD
Polovragi	546	53.8	76.5	-29.7	D	265.2	277.7	-4.5	N
Rm. Vâlcea	243	89.4	69.4	28.5	R	293.6	254.3	15.5	LR
Voineasa	587	110.3	72.8	51.5	ER	352.3	268.1	31.4	VR
Parâng	1585	82.4	90.6	-9.1	N	246.0	346.8	-29.1	VD
Average Oltenia	-	38.1	52.3	-27.2	D	163.1	201.5	-19.1	D
Ob. Lotrului	1404	132.8				313.8			

(ER=excessively rainy, VR= very rainy, R= rainy, LR = little rainy, N= normal, LD = little droughty, D= droughty, VD= very droughty, ED = excessively droughty) (Source: processed data from the ANM Archive)

At the end of July, on July the 31st, according to *the water reserve in the soil*, in the South-West of Oltenia prevailed severe (SD) and moderate (MD) drought. The almost satisfactory water reserve (AS) dominates much of the eastern and southeast part of the region, and in the north the reserve was almost optimal (AO) and even optimal (O) in the Tg. Jiu area. The rains of the period July 2-3, arrived at an opportune time after a month of excessive drought and saved, through their intensity, the serious situation in agriculture. Thus, at the end of the agricultural year, the Minister of Agriculture stated that the production of maize was one of the highest in the last 35 years, due largely to the agricultural technologies applied, but also to the cultivation of drought resistant maize varieties (drought in the summer season scheduled from the very beginning of the spring). The appreciation was consistent with the US Department of Agriculture (USDA), which estimated for 2017-2018 Romania's largest corn production in the last 35 years and expected Romania to replace Russia in the Vietnamese markets, Turkey and Lebanon, according to a report released in December ([http://goodnews.info.ro/usda-estimeaza-pentru-2017-2018-cea-mai-mare-productie-de-porumb-romaniei-din-ultimii-35 -for years/](http://goodnews.info.ro/usda-estimeaza-pentru-2017-2018-cea-mai-mare-productie-de-porumb-romaniei-din-ultimii-35-fc-for-years/)). This demonstrates that efforts to adapt to climate change can be successful in some situations.

3.1.3 Air temperature and rainfall characterization for August 2017

Air temperature. *Monthly average temperatures* were between 18.4°C at the southern boundary of the mountain range at Voineasa and 26.1°C in the extreme west at Dr. Tr. Severin, and their deviations from multiannual averages were between 1.2°C at Bechet in the southern extreme and 3.9°C at Dr. Tr. Severin, leading to the classification of the types of thermal time by Oltenia's relief steps from very warm (WS) on the restricted areas at Bechet and Tg. Logrești and warm (W) in most of the region (Table 4). Average air temperature calculated for the whole region was 23.7°C, and its deviation from normal was 3.2°C, confirming that August was warm "on average" in Oltenia. Maximum monthly temperatures in August were recorded on the 4, 5 and 6 of August and were between 33.8°C at Voineasa and 42.2°C at Calafat. Although the summer of 2017 took place in the context of minimum solar activity and in the absence of El Niño, we note that the maximum temperature values recorded in August at five meteorological stations became absolute thermal maxima being the highest in the history of their observations: 28.3°C at Parâng, 38.3°C at Tg. Logrești, 39.6°C at Tg. Jiu, 41.3°C at Dr. Tr. Severin (all recorded on the 5th of August) and 42.2°C at Calafat registered on the 6th of June. For these five weather stations, in the north and west of the region, August 2017 it was the hottest month of all time. We note the values: 40.8°C from Craiova (the 6th of August), which is the second value from the last 95 years, after the absolute thermal maximum of 41.0°C recorded on 08.10.1922; 38.7°C at Apa Neagră on the 5th of August is the second value after 38.8°C

recorded on 08.12.2015 and 29.2°C at Ob. Lotrului recorded on the 5th of August is the second value after the 29.9°C recorded on 08.25.2012.

Table 4. Characteristic air temperature values at soil surface recorded at the meteorological stations from Oltenia in August 2017 (Hm = altitude of the meteorological station, Δ = M-N = temperature deviation, CH = Hellmann Criterion, NVIII = temperature averages for August calculated for 1901-1990 – normals; MVIII = temperature averages for August 2017).

Meteorological Station	Hm	N08	M08	Δ =M-N	Hm	Tmax air		Tmin air		Tmax soil		Tmin soil	
						(°C)	Data	(°C)	Data	(°C)	Data	(°C)	Data
Dr.Tr. Severin	77	22.2	26.1	3.9	C	41.3*	5	11.6	24	69.0	4	9.4	24
Calafat	66	22.7	25.1	2.4	C	42.2*	6	9.2	24	53.0	5	10.4	24
Bechet	65	22.4	23.6	1.2	CL	40.4	5	8.2	24	56.3	6	10.7	31
Băilești	56	22.5	24.5	2.0	C	40.0	5	8.8	24	49.9	5	10.4	24
Caracal	112	22.4	25.3	2.9	C	39.3	6	10.8	24	41.7	6	13.6	24
Craiova	190	22.2	25.4	3.2	C	40.8	6	10.5	25	65.6	4	13.0	25
Slatina	165	22.2	24.6	2.4	C	39.3	5	8.0	24	45.0	6	11.4	24
Băcleș	309	20.9	23.9	3.0	C	38.3	5	11.0	23	-	-	-	-
Tg. Logrești	262	20.2	21.9	1.7	CL	38.3*	5	4.9	24	64.5	6	6.4	24
Drăgășani	280	21.5	24.9	3.4	C	38.7	4;5	10.3	24	44.5	6	13.2	24
Apa Neagră	250	20.1	22.6	2.5	C	38.7	5	3.5	24	48.6	4	6.9	24
Tg. Jiu	210	20.9	24.1	3.2	C	39.6*	5	6.4	24	63.3	5	6.0	24
Polovragi	546	19.4	21.9	2.5	C	35.1	5	7.2	24	56.5	5	4.6	24
Rm. Vâlcea	243	20.5	23.4	2.9	C	38.6	5	8.5	24	63.6	6	8.6	24
Voineasa	587	16.3	18.4	2.1	C	33.8	5	5.1	24	-	-	-	-
Parâng	1585	12.0	-	-	-	28.3*	5	5.2	23	-	-	-	-
Average Oltenia	-	20.5	23.7	3.2	C	38.3	5	8.1		55.5		9.6	
Ob. Lotrului	1404	11.8	13.9	2.1	C	29.2	5	0.6	24	-	-	-	-

Hm = altitude of the meteorological station, Δ =M-N = deviation from the normal of the average temperature in August, CH = Hellmann Criterion, N08= temperature averages for August calculated for 1901-1990; M08 = temperature averages for August 2017 (EW= excessively warm, VW= very warm, W=warm, WS=warmish, N=normal) (Source: processed data from the ANM Archive)

For the period 4-5 August 2017, a red and orange code for the whole country was issued for high temperature and thermal discomfort, being the first such warning for the whole of Romania throughout the ANM's history. In the 3, 4 and 5 of August, the ITU thermal comfort index exceeded the critical threshold of 80 across the country except for the mountain range. The maximum value of this parameter for the whole country was 86.3 at Brăila and in Oltenia 86.0 at Calafat on the 6th of June. The heat wave in the period July 29 – August 12 (15 days) with the apogee in August 4, 5 and 6 data is a new record for Romania and is still proof of the climatic warming at the regional level and confirming the fact that at the regional level 2017 was also a year of climatic extremes. The second heat wave of August, lasting 6 days, was recorded in the period August 15-20.

The most intense heat wave in August of the entire meteorological observation history (July 29- August 12) was due to intense, stable and persistent tropical continental circulation (cT), and at 850 hPa level (about 1500 m altitude) for three days the air temperature above Romania was between 22-24°C (Fig. 3). The massive extension of hot air to the north has exceeded the 70°N parallel, thus constituting an absolute climatic record for the continent of Europe.

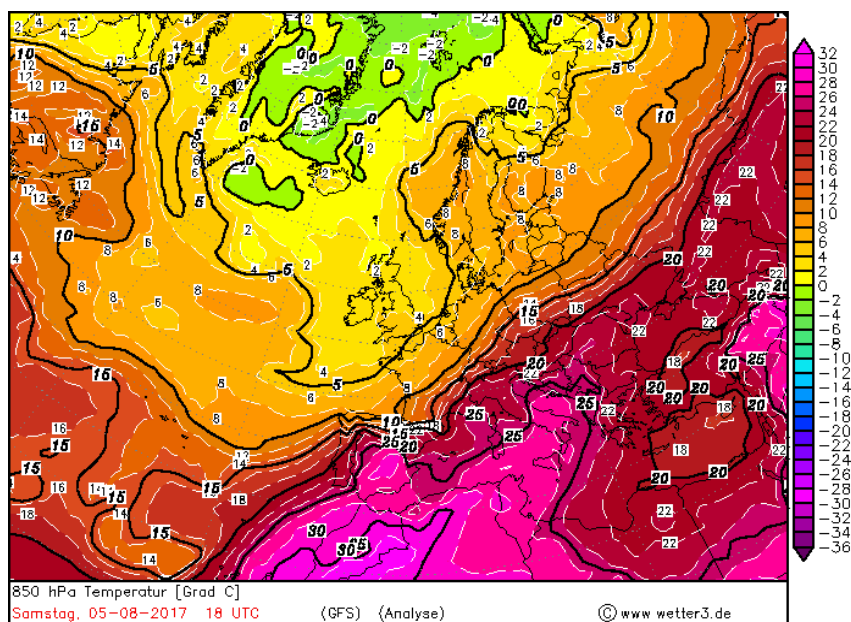


Fig. 3. Temperature field over Europe at the 850 hPa level (about 1500 m altitude) on August 5, 2017, 18 UTC at the maximum intensity of the heat wave from the first part of August (after: <http://www1.wetter3.de/Archiv/>).

As a result, in August, for 18 days (58.1% of the month) the weather was excessively warm, canicular in the afternoon. Across the country, in the 5th and 6th of August, there were 24 temperature records. Monthly air temperature minima were recorded between 23-25 of August and were between 3.5°C in Apa Neagră and 11.6°C at Dr. Tr. Severin with the average for the entire region of 8.1°C. At the soil surface, the peak temperatures were recorded in the heat wave of 4-6th of August and were between 47.1°C at Caracal and 69.0°C at Dr. Tr. Severin, with the average for the whole region of 55.5°C, being the largest for all summer. Soil temperature minima were recorded between August 24-31 and were between 4.6°C at Polovragi and 13.6°C in Caracal, with the region's average of 9.6°C, lower than in July.

Due to the variability of the Sun-Earth geometry at Oltenia's latitude, in August, the decrease in the day's duration is of 1h and 20' (the first major decrease of the day's duration in one month during the year), with a daily average of 2'35", and after August 15 the night time exceeds 10 hours and the day falls below 14 hours and consequently **the daily minimum temperatures gradually decrease and the mornings cool down**. This fact determines **the thermal specificity of August**: monthly thermal peaks are frequently recorded in the first part of the month, monthly thermal minima in the last part of the month, and the heat of the summer days is gradually decreasing. In August, the decrease in the monthly average temperature compared to July calculated for Oltenia is 0.5°C, the first decrease of the monthly average temperature during the year.

The parameter charts for air temperatures in August (daily maxima, daily averages and daily minima calculated for the entire Oltenia region) show a significant decreasing linear trend and the daily average temperatures were the fastest decreasing (Fig. 4).

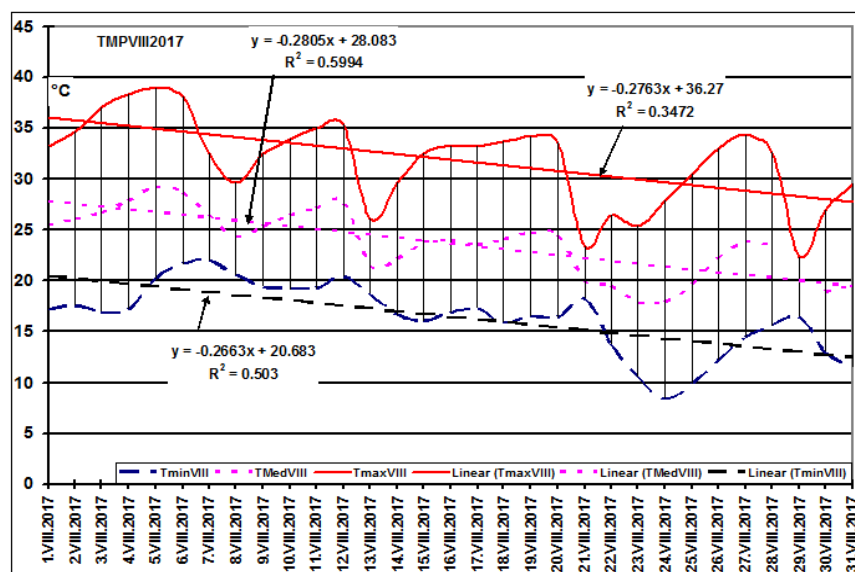


Fig. 4. Variation of average air temperatures, daily maxima, daily averages and daily minima calculated for the entire Oltenia region in August 2017 (Source: processed data from the ANM Archive)

Atmospheric rainfalls. *The monthly rainfall quantities in August* ranged between 5.0 l/m² in the Romanița Plain at Caracal and 110.3 l/m² in Voineasa, and their percentage deviations from multiannual averages were -88.5% at Tg. Jiu and 51.5% at Voineasa, leading to the classification of the rainfall time types on Oltenia's relief steps from excessively droughty in the extreme south to Bechet in

the Getic Piedmont and in the hills to the excessively rainy (ER) in a restricted area at Voineasa . The average monthly rainfall quantities calculated for the entire region was 38.1 l/m^2 , and its percentage deviation from the multiannual average was -27.2% denoting that August, "on average", droughty (D). The rains of August were due to wet and cool air advections and cyclones from the Black Sea or from the end of the atmospheric fronts of some Icelandic cyclones. At the end of August, on the 31st, extreme (ED), strong (SD) and moderate (MD) drought dominated most of Oltenia with the exception of the northern region where it was almost satisfactory (AS).

3.4. Characterization of the seasonal values of the main climatic elements

The average seasonal temperatures were between 18.1°C at Voineasa and 25.6°C at Dr. Tr. Severin (Table 5) and their deviations from normal were between 1.6°C at Tg. Logrești and 3.6°C at Tg. Logrești, determining according to Hellmann Criterion a warm summer (W) in most of Oltenia, and in the extreme west at Dr. Severin was very warm (VW).

Table 5. General thermal and pluviometric particularities of the summer of 2017 (Hm = meteorological station altitude, V2017 = temperature average values for the summer of 2017 ($^\circ\text{C}$), NtV = normal values of seasonal average summer temperature ($^\circ\text{C}$), $\Delta = \text{V}-\text{N}$ = deviations from the normal ($^\circ\text{C}$), SV = rainfalls sums for the summer of 2017 (l/m^2), NV = normal summer rainfall values (l/m^2), $\Delta = \text{S}-\text{N}$ = abaterile față de normală (l/m^2), $\Delta\%$ = percentage deviations from the normal, CrH = Hellmann Criterion).

Meteorological Station	Hm	Thermal regime ($^\circ\text{C}$)				Pluviometric regime (l/m^2)				
		NtV	V2017	$\Delta=\text{V}-\text{N}$	CrH	SV2017	NV	$\Delta=\text{S}-\text{N}$	$\Delta\%$	CrH
Dr. Tr. Severin	77	22.0	25.6	3.6	VW	66.0	160.0	-94	-58.8	ED
Calafat	66	22.3	24.8	2.5	W	89.2	146.8	-57.6	-39.2	VD
Bechet	65	22.2	23.9	1.7	WS	153.8	146.8	7.0	4.8	N
Băilești	56	22.1	24.0	1.9	WS	100.8	150.5	-49.7	-33.0	VD
Caracal	112	22.0	24.4	2.4	W	105.8	167.4	-61.6	-36.8	VD
Craiova	190	21.7	24.4	2.7	W	96.6	164.7	-68.1	-41.3	VD
Slatina	165	21.6	23.7	2.1	W	148.8	184.9	-36.1	-19.5	D
Băcleș	309	20.4	23.2	2.8	W	120.9	152.5	-31.6	-20.7	D
Tg. Logrești	262	19.9	21.5	1.6	WS	158.2	165.4	-7.2	-4.4	N
Drăgășani	280	20.9	23.6	2.7	W	149.0	185.6	-36.6	-19.7	D
Apa Neagră	250	19.1	22.1	3.0	W	104.8	232.0	-127.2	-54.8	ED
Tg. Jiu	210	20.5	23.4	2.9	W	158.2	219.2	-61.0	-27.8	VD
Polovragi	546	18.9	21.1	2.2	W	265.2	277.7	-12.5	-4.5	N
Rm. Vâlcea	243	20.2	22.6	2.4	W	293.6	254.3	39.3	15.5	LR
Voineasa	587	16.2	18.1	1.9	WS	352.3	268.1	84.2	31.4	VR
Parâng	1585					246.0	346.8	-100.8	-29.1	VD
Average Oltenia		20.7	23.1	2.4	W	163.1	201.5	-38.4	-19.1	D
Ob. Lotrului	1404	11.7	13.6	1.9	WS	313.8				

(Source: processed data from the ANM Archive)

There were 5 heat waves recorded in the intervals: June 21- July 2 (11 days), July 7-12 (6 days), July 20-24 (5 days), July 29- August 12 (15 days) and August 15-20 (6 days), totaling 43 days, indicating that 47.3% of the summer was hot. There were 6 absolute temperature records (5 in August and 1 in June) and four values in second place in descending order of full data rows (one in June and 3 in August).

The annual rainfall values ranged from 66.0 l/m² (lower than normal in June) to the extreme west at Dr. Tr. Severin and 352.3 l/m² in Voineasa, and their percentage deviations from the multiannual averages, negative in almost all Oltenia, were between -58.8% at Dr. Tr. Severin and 31.4% at Voineasa, which according to Hellmann criterion, that summer 2017 was droughty in most of the region except for a restricted area in the north-east (Rm. Vâlcea-Voineasa) where it was rainy. There was only one rainy period, lasting 36 hours, during July the 2-3.

4. CONCLUSIONS

The summer of 2017 took place during the minimum solar activity and in the absence of the El Niño climatic process and was marked by long dry periods, heat waves totaling 43 days (47.3% of the summer).

There were 6 absolute temperature records: 38.8°C at Craiova in June 29, 28.3°C at Parâng, 38.3°C at Tg. Logrești, 39.6°C at Tg. Jiu, 41.3°C at Dr. Tr. Severin (all recorded on August 5) and 42.2°C at Calafat recorded on August 6, and four maximum temperature values that have come close to or equaled absolute thermal maxima at the respective stations: 38.9°C recorded in Getic Piedmont, at Slatina on June 29, 40.8°C at Craiova (June 6) which is the second value in the last 95 years, after the absolute thermal maximum of 41.0°C recorded at 08.10.1922, 38.7°C at Apa Neagră recorded on August 5 is the second value after 38.8°C recorded at 08.10.2015 and 29.2°C at Ob. Lotrului recorded on August 5 is the second value after the 29.9°C recorded on 08.25.2012. For the period August 4-5, 2017, a red and orange code for the whole country was issued for high temperature and thermal discomfort, being the first such warning for the whole of Romania throughout the ANM's history. In the data of August 3, 4 and 5, ITU's thermal comfort index exceeded the critical threshold of 80 across the country except for the mountain range. The maximum value of this parameter for the whole country was 86.3 at Brăila and in Oltenia 86.0 at Calafat on the 6th of June. The heat wave between July 29- August 12 (duration of 15 days) at the peak of 4, 5, 6.VIII is a new climax for Romania, being the most intense and the most extensive after the first part of the month of 1951 and with the longest duration. So in summer of 2017 it was extremely hot and dry, in which only a rainy interval of 36 hours (2-3.VII) was recorded which, by its appearance in the middle of the dry period of the first two months of summer, saved the crops in vegetation stages requiring significant

amounts of precipitation. The space-time extension of dry time was 58.3%, and the warm weather was 95.6%. However, at the end of the agricultural year, maize production was one of the highest in the last 35 years, due largely to the agricultural technologies applied, but also to the cultivation of drought resistant maize varieties (drought in the summer season being from the beginning of the spring). The conclusion was consistent with the US Department of Agriculture (USDA), which estimated for 2017-2018 Romania's largest corn production over the last 35 years and expects Romania to replace Russia in the markets of Vietnam, Turkey and Lebanon, according to a report released in December (<http://goodnews.info.ro/usda-estimeaza-in-2017-2018-cea-mai-mare-productie-de-porumb-romaniei-din-ultimii-35-de-ani/>). This fact demonstrates that efforts to adapt to climate change can be successful in some situations. As a whole, this study shows that climatic warming continued at the regional level (as well as globally) during the minimum solar activity, although previously it was estimated that during the minimum solar activity the global temperature would fall to the normal values. As at global level, in Oltenia and Romania, 2017 was a year of climatic extremes. The conclusions of the paper are correlated with the expansion of the Mediterranean climate towards the north, which is related to global warming.

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