

THE SUMMER OF 2018 IN SOUTHWESTERN ROMANIA- CONTRASTS AND TRENDS

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ABSTRACT. – **The summer of 2018 in southwestern Romania-contrast and trends.**

The study performs a diagnosis of weather in southwestern Romania, from both thermal and precipitation perspective, during June to August 2018 with the aim to establish if this year follows the warming trend (e.g. temperature rising) of the warm season observed in the last decades. The summer diagnosis was made using observational data recorded at the meteorological weather stations from southwestern Romania. The summer 2018 was characterized by positive thermal deviations of the mean temperatures in respect to 1981-2010 climatological temperatures, following the tendency of the last 18 years, except for July which had a negative deviation. It was a summer of thermal contrasts. In June was recorded the absolute maximum temperatures for many days, while in July 4 weather stations had the lowest values of the maximum temperature ever recorded. Considering the precipitation, it was a summer rich in precipitation except for the August month which recorded dry days, with a rainfall deficit in most part of the Oltenia region. Bechet and Bâcleș weather stations registered a record for the 24 hours precipitation amounts in June.

Keywords (4-6): temperature records, mean temperature, heavy precipitation

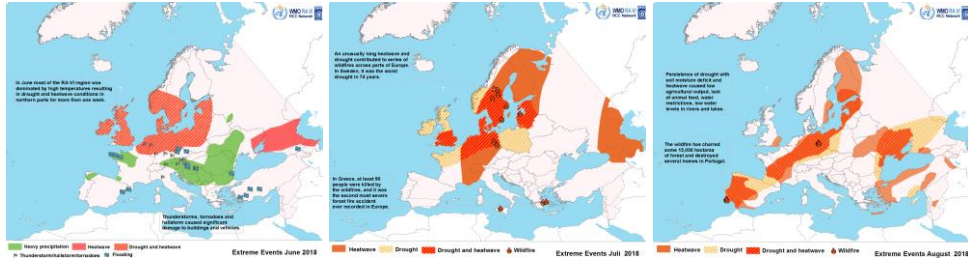
1. INTRODUCTION

In Europe, the summer of 2018 was unspecific one, Northern Europe becoming an antipole of Southern Europe due to the prevalence of the Azores ridge up to Scandinavian Peninsula and North of Russia. While Northern countries set records of high temperatures, heatwaves and drought that led to devastating wildfires, countries from Southeastern Europe experienced large precipitation amounts in June. In the central-eastern basin of the Mediterranean Sea extreme rainfall events occurred and, as a consequence, flooding were recorded in countries like Greece, Bulgaria and Romania. The hot conditions extended in July, causing severe wildfires, especially in Greece where 90 people were killed. In August heat waves and drought were present from Southwest to North of Europe and extended in Southeastern part of the continent also (Fig. 1a-c).

Romania made no exception from this regime. Accordingly to Romanian Ministry of Environment (press release, 2019) the year of 2018 was the third the warmest year in record since 1901, after 2015 and 2007, with a mean temperature of 11.57° C. More important, 9 of 10 the warmest years from 1900 – 2018 period were

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recorded after 2000, the warming tendency from the last two decades being obvious. Positive thermal deviations were recorded in June (0.9° C) and in August (1.8° C), and negative in July. Regarding precipitation regime, the annual amount of 2018 in Romania was 10% higher than multiannual amount (1981-2010), with positive deviations in June and July and negative deviation in August.



a) b) c)

Fig.1 Extreme events in Europe: a) June ; b) July; c) August
https://www.dwd.de/EN/ourservices/rcccm/int/rcccm_int_eev.html

2. DATA AND METHODS

2.1. Data used

The diagnosis of the summer was made using data recorded by meteorological weather stations from Southwestern Romania, validated and managed by the Romanian National Meteorological Administration. The results were compared with the 1981 - 2010 climatology period. The mean sea level pressure and geopotential height, and the composite anomaly maps were computed with the help of Earth System Research Laboratory – Physical Science Division (<https://www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html>). The extreme events maps were provided by RAVI Regional Climate Centre Offenbach Node on Climate Monitoring RCC-CM RCC Node-CM).

2.2. Methods

The deviation of the monthly precipitation amount comparing to median of the reference period (1981 – 2010), for the summer of 2018 was calculated using the Hellman criterion.

$$\Delta = M - D ; \text{Deviation } \Delta\% = \frac{\Delta}{D} * 100 \quad (1.1.)$$

where,

D- the median of the reference period;

M- the summ of precipitation in a month

$\Delta\%$ deviation in percentages with first two decimals approximated

The pluviometric types applied to monthly precipitation amounts can be, accordingly to Hellman criterion, (Bogdan and Niculescu, 1999):

- extremely rainy >50 (ER),

- very rainy 30.1 – 50.0 (VR),
- rainy 20.1 – 30.0 (R),
- little rainy 10.1 – 20.0 (LR),
- normal -10.0 – 10.0 (N),
- less rainy -20.0 – - 10.1,
- rainless -30.0 – -20.1,
- very rainless -50.0 – -30.1;
- extremely rainless >-50.0.

3. RESULTS AND DISCUSSIONS

To establish the synoptic features that determined the summer regime, the mean sea level pressure and geopotential height, for each month were averaged. In June two low-pressure areas, connected, extended over northeastern and southeastern of the continent, while western part of the Europe was influenced by the Azores High (Fig. 2a). In July the anticyclonic field extended over Central, Western and Northern Europe and a high-pressure belt formed between Azores High and East-European High. Southeastern maintained in a low-pressure field, mainly due to the Mediterranean cyclogenesis (Fig. 2b). The high-pressure belt moved toward South and, in August influenced all the countries from West to East, the Azores High being the strongest. The low-pressure field was still present in Southeastern, but moved toward the Turkey (Fig. 2c). Romania had strong negative anomaly of the pressure in June and July (around 3 hPa) that became positive in August, mainly due to East-European High ridge (Fig. 2 d-f).

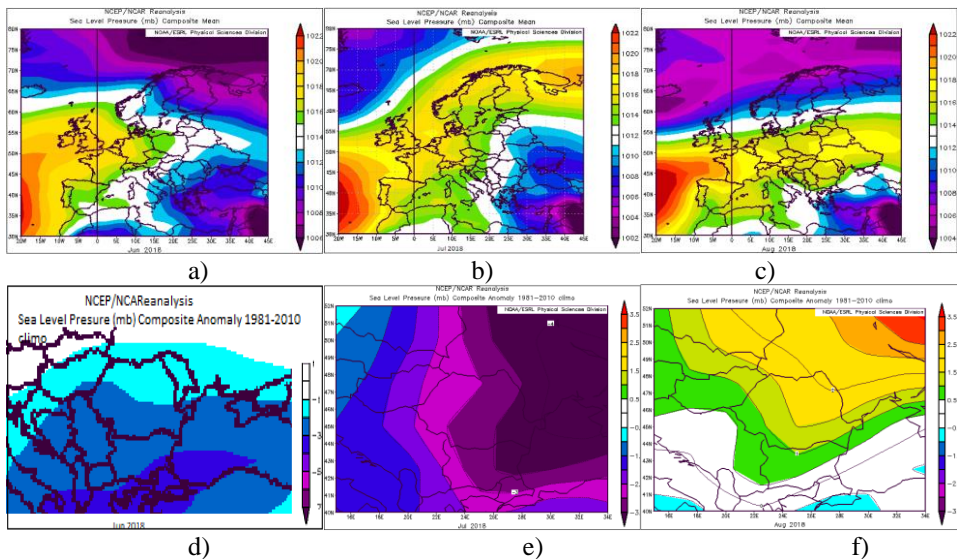


Fig. 2. Sea level pressure: composite mean a) June ; b) July; c) August 2018; composite anomaly comparing to 1981-2010 d) June; e) July; f) August

In the middle troposphere, at 500 hPa, the geopotential maps highlight the trough feature that dominated especially the eastern half of the continent, with averaged values of 570 – 573 dam in June (Fig. 3a). In July the averaged values of geopotential increased as a result of high-pressure belt forming, except for the Northeastern of the continent where a cut-off feature was present. August maintained its stable and warm characteristics and the southern half of the continent was influenced by a high-pressure ridge (Fig. 3c). As for geopotential anomalies, the zoomed maps over Romania exhibited a strong negative anomaly in July (-15 hPa for Oltenia), due to the cut-off systems present in that area, whereas in August Southwestern of Romania recorded positive geopotential anomaly (40-50 dam). In June, for Oltenia geopotential height had no deviation from standard values (1981-2010) (Fig. 3).

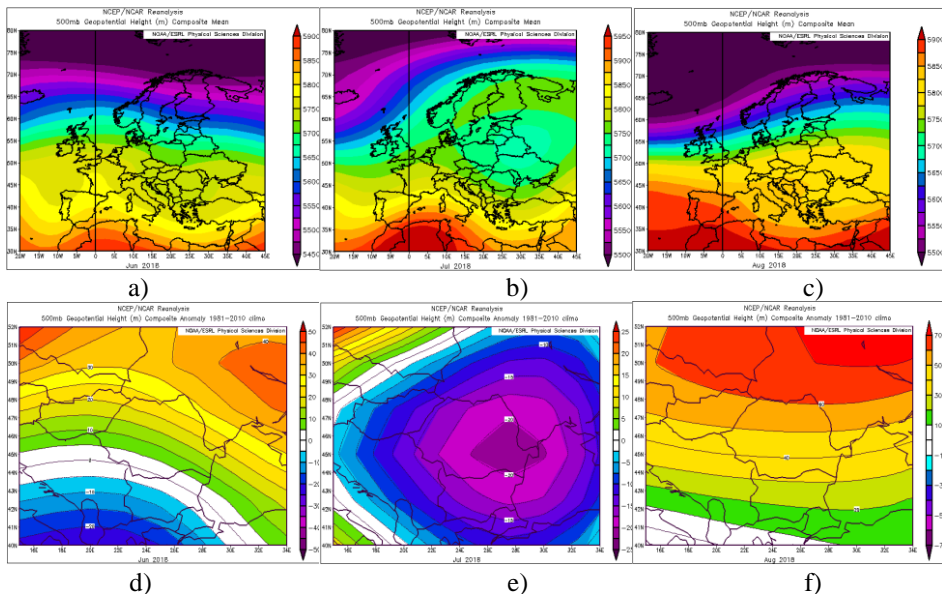


Fig. 3. 500 mb Geopotential Heigh: a) June ; b) July; c) August; 2018 average values 2018; composite anomaly comparing to 1981-2010: d) June ; e) July; f) August

Considering these synoptic features and using meteorological data recorded at 13 weather stations from Oltenia, a diagnosis of the three months of the summer was made with the aim to establish if this region of Romania followed the national and european trend in 2018. For every station and every month a mean air temperature was calculated, also for the region.

In June, the monthly mean air temperature in Oltenia was 21.2° C, higher than multiannual mean with 0.7° C, with a maximum of 22.5° C at Dr. Tr. Severin and a minimum of 19.3° C at Polovragi. All the weather stations had positive deviation, comparing to 1981 – 2010 climatological period (Fig. 4a).

In July, the monthly mean air temperature in Oltenia was 22.1° C, lower than the multiannual monthly mean temperature of 22.5° C. In this month all stations had the

monthly mean air temperature lower than or equal with the multiannual temperature, with a maximum at Calafat (23.8° C) and a minimum at Polovragi (20.1° C - Fig. 4b).

In August, the monthly mean air temperature in Oltenia was 23.4° C, higher than multiannual mean with 1.5° C, with a maximum of 24.0° C at Dr. Tr. Severin and a minimum of 21.2° C at Tg. Logresti. Like the first month of the summer, the last one had monthly mean air temperature higher than multiannual mean temperature at all stations (Fig. 4c).

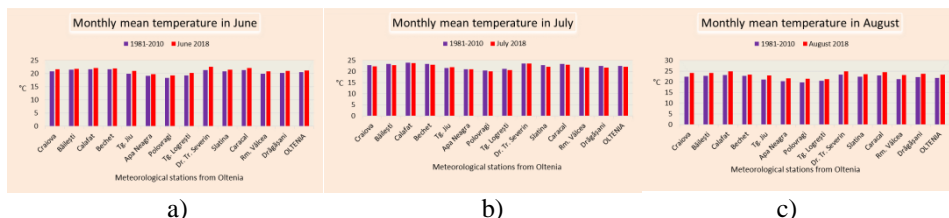


Fig. 4. Monthly mean temperature: a) June ; b) July; c)August;

The monthly average of maximum temperature for June was 27.8° C, with 0.8° C higher than climatological norm. The lowest value of maximum temperature and the highest were recorded at Calafat (17.3° C, 35.2° C). In the first half of June 2018 were recorded records of absolute maximum air temperature (Table 1), as it can be observed (Fig. 5a), the fluctuation of average of the maximum temperature has the largest values in the first two weeks, with a maximum of 32.5° C in 13 June.

Table 1. Record of absolute maximum temperature in June

Date	Meteorological weather station	Record of maximum temperature °C	Past Record (* C/year)
1 June	Slatina	31.9	31.6/2017
1 June	Rm. Valcea	31.6	31.5/1944
6 June	Bechet	33.3	33.0/1998
13 June	Bechet	35.0	35.0/2000, 2010

The monthly average of maximum air temperature of July was 28.4° C, below the multiannual average of 29.4° C. The lowest maximum temperature was of 20.0° C at Apa Neagra and the highest was 34.0° C recorded at Calafat. The monthly average of minimum air temperature was 16.6° C, having a positive deviation of 0.8° C against the multiannual norm, the minimum temperatures ranging between 7.1° C at Tg. Logresti and 22.0° C at Dr. Tr. Severin (Fig. 5b). In 8 July 2018 were recorded four the lowest values of absolute maximum temperature (Table 2). For this day the average of maximum temperature had the largest decrease down to 22.6° C (Fig. 6b).

Table 2. Records of the lowest maximum air temperature in July

Date	Meteorological weather station	Record of maximum temperature °C	Past Record (* C/year)
8 July	Tg. Jiu	20.4	22.0/1974
8 July	Apa Neagră	20.8	21.4/1955
8 July	Slatina	21.3	22.3/1984
8 July	Dragasani	20.3	22.2/1974

The monthly average of maximum air temperature of August was 29.9° C, just a little higher than climatological norm of 29.2° C, with the lowest value of 21.5° C at Tg. Jiu and the highest value of 36.3° C at Bechet. The monthly average of minimum air temperature was 17.1° C, with 1.5° C positive deviation, the minimums ranging between 11.2° C at Tg. Logresti and 23.0° C at Dt. Tr. Severin (Fig. 5c)

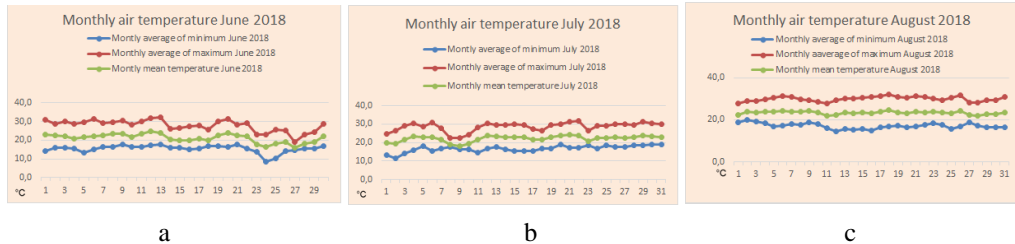


Fig. 5. Monthly air temperature: a) June; b) July; c) August;

Comparing to the climatological norm of June for 1981-2010 interval, June 2018 had a mean deviation of 99.1% for Oltenia, and accordingly to the Hellman criterion that represent the superior limit of an extremely rainy month. Using the same criterion for each station, it results 10 stations having extremely rainy regime, 1 having very rainy regime, 1 station having rainy regime and 1 with little rainy regime. The monthly precipitation deviation, calculated in percentage, it was positive for all meteorological stations. The lowest calculated value it was 11% at Tg. Jiu and the highest value 189% at Dragasani (Fig.6).

The month of July 2018 has a mean deviation of 78.5% for Oltenia, which is above the superior limit of an extremely rainy regime. The analysis for each station point out that were 8 stations with extremely rainy regime, 3 stations with very rainy regime and 1 station with normal regime. The monthly precipitation deviation, calculated for July it was positive for all meteorological stations, the highest value being recorded at Bechet (188.3%) and the lowest at Apa Neagra (5.2% - Fig.6).

August 2018 had a mean deviation of -36.4% for Oltenia, resulting a value below the limit of a rainless month. The analysis for each station point out that were 6 stations with extremely rainless regime, 2 stations with very rainless regime, 1 station with less rainy regime, 1 station with little rainy regime and 1 with extremely rainy regime. The monthly precipitation deviation for August 2018 was negative for almost all the meteorological stations. Positive deviations were calculated for 3 stations located in northwestern and west of Oltenia (Dr. Tr. Severin, Apa Neagra and Tg. Jiu). The lowest deviation it was at Calafat (-78.8%) and the highest at Dr. Tr. Severin (51.2%).

In June 2018 the smallest precipitation amounts were recorded in southern of the Oltenia region, with a minimum of 65 mm at Bailesti, and the largest amounts especially in east of the region, with a maximum of 234.6 mm at Rm. Valcea (Fig. 7a). In July 2018, among the smallest precipitation amounts were recorded in south and west of Oltenia, with a minimum of 78.6 mm at Dr. Tr. Severin and a maximum of 184.8 mm at Polovragi (Fig. 7b). In August 2018 the precipitation were scarce, except for the northwestern of Oltenia, where positive deviation from climatological norms

were recorded. The maximum precipitation amount was recorded at Tg. Jiu (76.8 mm) and the minimum was recorded at Caracal and Calafat (9.2 mm – Fig. 7c).

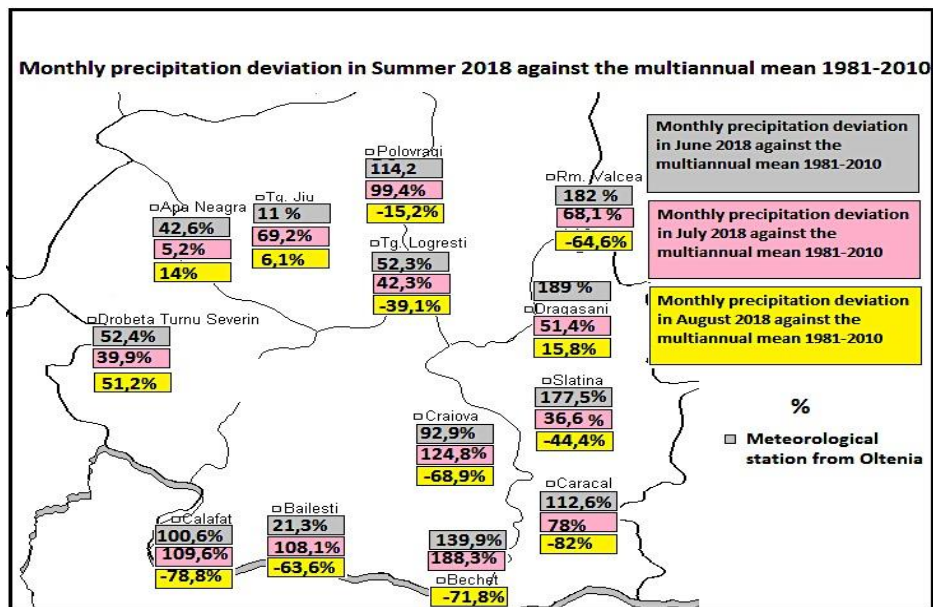


Fig. 6. Percentage monthly precipitation deviation in June, July and August (Hellman Criterion)

In June 2018 records were attained for the largest 24 hours precipitation amount at Bechet (51.2 mm), the old record being of 42.7 mm (1975).

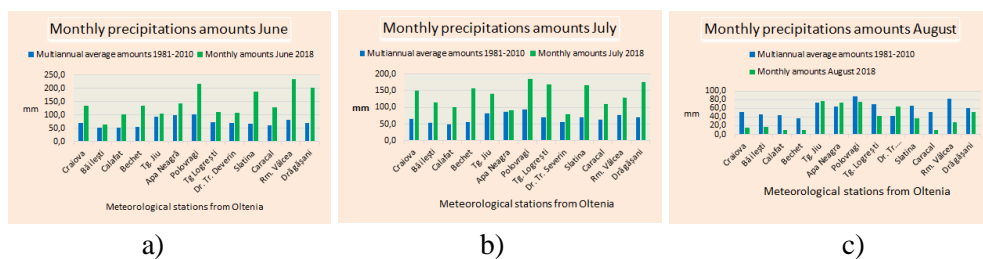


Fig. 7. Monthly precipitation amounts: a) June; b) July; c) August;

In Figure 8 a-b, the deviation of mean air temperatures and precipitation of the summer 2018 in Oltenia were calculated. The mean temperature deviation was above the 1981-2010 climatological norms for all meteorological stations. The largest deviation was of 1.1° C recorded at Tg. Jiu, and the smallest was of 0.19° C, recorded at Bechet.

For Oltenia region, the mean temperature deviation of the 2018 summer it was 0.6° C, following the trend of the last 18 years. Regarding the pluviometric regime, the recorded precipitation amounts were bigger than the climatological norms, the

largest deviation being at Dragasani (76.1 mm above the norm). In contrast, the minimum it was at Bailesti (13.7 mm).

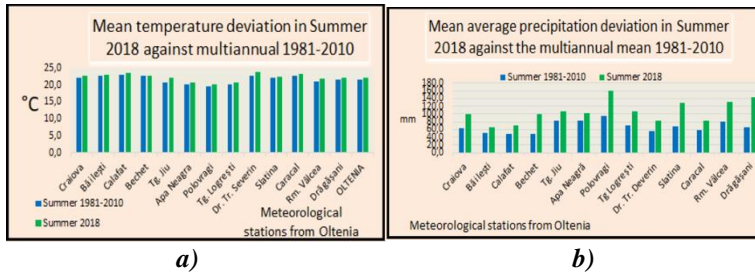


Fig. 8. Summer 2018 against multiannual mean 1981-2010 a) Mean temperature deviation b) Mean average precipitation deviation

During the 2018 summer the Oltenia Regional Meteorological Centre issued 275 yellow code alerts and 30 orange code alerts for immediate severe weather phenomena.

5. CONCLUSIONS

The present study focused on the contrasts recorded in thermal and synoptic fields, and on the warming trend. The contrast between Northern and Southern Europe represented the starting point of the study. In Northern Europe the persistence of a high-pressure fields determined a poor precipitation regime, heat waves and records of the absolute maximum air temperatures. All these creating a favorable background for wildfires on wide areas. The Arctic environment is highly sensitive and it warms much faster than other regions. In southern and central-eastern basin of the Mediterranean Sea had formed many low pressure systems that caused heavy precipitation and floods, especially in the Adriatic Sea coast.

The study continued with the analysis of Southwestern Romania regime, where the anomaly of the mean sea level pressure had negative values in June and July and positive values in August. In the middle troposphere, at 500 hPa, negative anomalies were only in July, positive in August and close to the climatological norms in June.

The diagnosis of the summer 2018 showed a positive deviation of the mean temperatures with 0.6° C with respect to 1981-2010 climatological norms for Oltenia, although the deviation of July was slightly below norms, following thus the last 18 years tendency of warming.

It was a summer of thermal fluctuations, with contrasting maximum temperatures in the first half of the June, absolute maximum temperature records being achieved. Conversely, in July the maximum temperatures were below climatological norms, with a peak in 8 July when the lowest values of the maximum temperature for this day were recorded.

The mean maximum and minimum air temperatures had positive deviation in the months of the 2018 summer, except for July, when the deviation was negative (-1°C).

Regarding the pluviometric regime, in Southwestern Romania it was an abundant precipitation regime even if in August many rainless days were recorded, resulting a deficiency of precipitation in almost the entire Oltenia region. The largest precipitation amounts were recorded in June, when the 24 hours precipitation amount record has been achieved.

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