



## **VERIFICATION OF THE SEECOF-17 SUMMER 2017 CLIMATE OUTLOOK AND SEASONAL BULLETIN FOR THE TERRITORY OF SERBIA**

Belgrade, 9 October 2017

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## Temperature

According to the SEECOF-17 outlook for the summer 2017 in Serbia, above - normal temperature was indicated in Serbia, relative to the 1981–2010 climatological base period (*Figure 1*).

Climatological monitoring showed that the summer of 2017 was warm in entire Serbia with above-normal temperature based on the tercile method (*Figure 2*).

The outlook for a warm summer was correct. Verification showed that the temperature reached upper tercile in entire Serbia which was indicated in the outlook with the 50% probability.

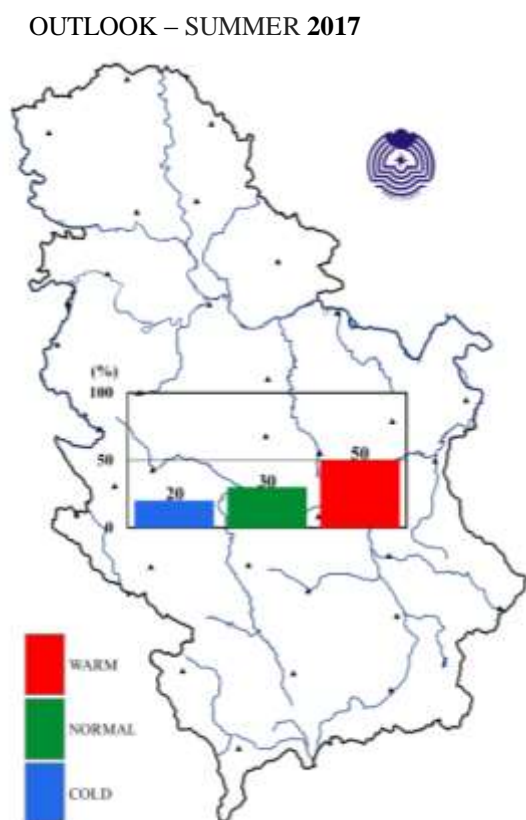


Figure 1. SEECOF-17 - summer temperature outlook

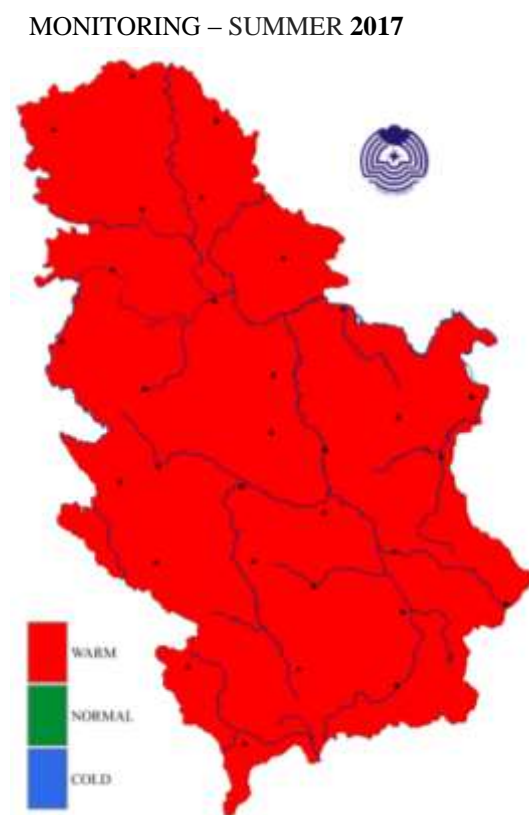


Figure 2. Monitoring of the summer temperature based on tercile method relative to the 1981-2010 base period

Note: Climatological analysis of meteorological elements was performed on the basis of the data obtained from 28 main meteorological stations. Apart from the data for the detailed analysis for precipitation, data from 22 climatological and 91 precipitation stations were used.

# Precipitation

The SEECOF-17 climate outlook for the summer 2017 in Serbia indicated approximately equal probabilities for below, near and above-average conditions (*Figure 3*). Precipitation monitoring showed dry winter conditions in almost entire Serbia (*Figure 4*).

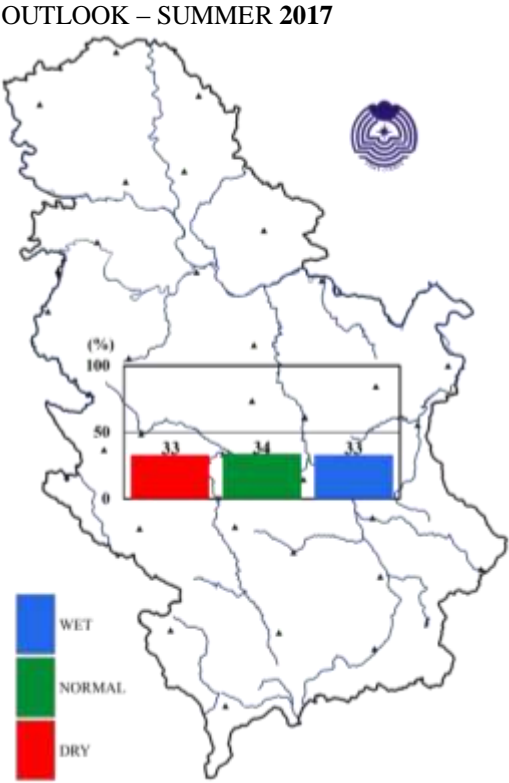


Figure 3. SEECOF-17 - summer precipitation outlook

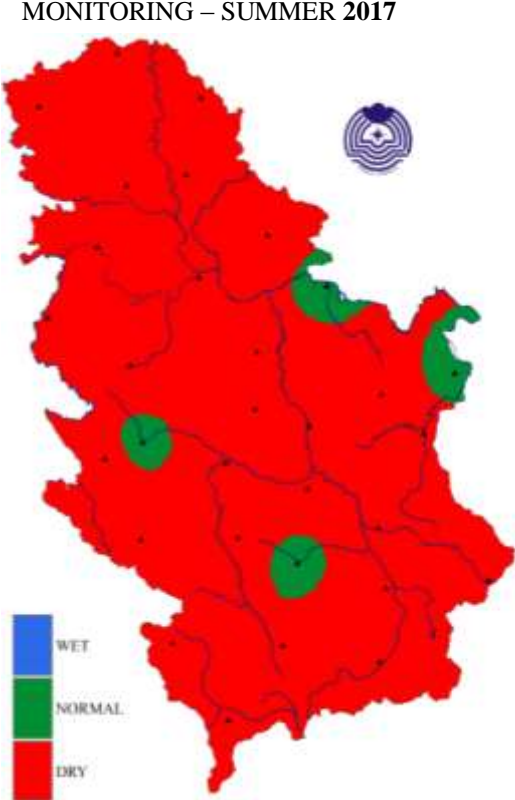


Figure 4. Monitoring of the summer precipitation based on the tercile method relative to the 1981-2010 base period

Summer 2017			Air Temperature (°C)			
Station	Rank *	Rank **	33	50	66	Observed value
<b>Beograd</b> (1888-2017)	2	2	21.6	22.0	22.9	25.4
<b>Palić</b> (1945-2017)	3	3	20.9	21.3	21.9	23.5
<b>Sombor</b> (1942-2017)	3	3	20.6	21.0	21.3	23.1
<b>Novi Sad</b> (1948-2017)	2	2	20.8	21.0	21.6	24.1
<b>Zrenjanin</b> (1946-2017)	2	1	21.0	21.2	21.7	24.6
<b>Kikinda</b> (1948-2017)	3	3	20.8	21.3	21.7	23.7
<b>Banatski Karlovac</b> (1986-2017)	1	1	20.9	21.3	21.8	23.6
<b>Loznica</b> (1952-2017)	3	3	20.7	21.0	21.7	23.7
<b>Sremska Mitrovica</b> (1925-2017)	4	2	20.5	20.8	21.2	23.1
<b>Valjevo</b> (1926-2017)	3	2	20.5	20.9	21.6	23.8
<b>Kragujevac</b> (1925-2017)	3	2	20.6	21.2	21.6	23.7
<b>Smederevska Palanka</b> (1939-2017)	1	1	20.8	21.3	21.8	24.0
<b>Veliko Gradište</b> (1926-2017)	3	2	20.4	21.1	21.4	23.4
<b>Crni Vrh</b> (1967-2017)	4	4	15.9	16.3	16.6	18.4
<b>Negotin</b> (1927-2017)	8	4	22.0	22.7	23.1	24.7
<b>Zlatibor</b> (1950-2017)	3	3	16.3	16.8	17.3	19.3
<b>Sjenica</b> (1946-2017)	3	3	15.3	15.9	16.2	17.6
<b>Pozega</b> (1952-2017)	4	4	18.9	19.4	19.5	21.0
<b>Kraljevo</b> (1926-2017)	3	2	20.6	21.0	21.5	23.5
<b>Kopaonik</b> (1950-2017)	3	3	11.5	12.1	12.5	14.2
<b>Kursumlija</b> (1952-2017)	4	4	19.0	19.4	19.9	21.2
<b>Krusevac</b> (1927-2017)	7	4	20.7	21.1	21.5	23.2

<b>Cuprija</b> (1948-2017)	2	2	20.3	21.0	21.3	23.8
<b>Nis</b> (1925-2017)	7	4	21.2	21.9	22.2	23.9
<b>Leskovac</b> (1948-2017)	4	3	20.4	20.9	21.1	23.0
<b>Zajecar</b> (1929-2017)	9	5	20.9	21.8	22.0	22.6
<b>Dimitrovgrad</b> (1945-2017)	6	3	18.8	19.4	19.7	21.2
<b>Vranje</b> (1926-2017)	12	6	20.3	21.1	21.3	22.7

\*Rank –period of stations work (warmest season)

\*\*Rank – 1981-2017 period (warmest season)

Summer 2017			Precipitation sums (mm)			
Station	Rank*	Rank**	33	50	66	Observed Value
<b>Beograd</b> (1888-2017)	12	5	169.3	222.6	264.1	98.9
<b>Palić</b> (1945-2017)	27	12	161.4	193.3	219.0	141.0
<b>Sombor</b> (1942-2017)	15	7	180.2	200.9	215.1	131.7
<b>Novi Sad</b> (1948-2017)	4	3	174.5	215.3	236.8	95.1
<b>Zrenjanin</b> (1946-2017)	5	2	155.3	194.7	222.8	74.8
<b>Kikinda</b> (1948-2017)	16	7	152.4	181.3	205.7	109.7
<b>Banatski Karlovac</b> (1946-2017)	10	7	146.6	204.4	246.0	118.4
<b>Loznica</b> (1926-2017)	25	10	237.8	268.9	309.0	191.1
<b>Sremska Mitrovica</b> (1925-2017)	12	3	173.9	200.3	226.1	109.5
<b>Valjevo</b> (1926-2017)	13	6	214.0	252.4	286.7	140.3
<b>Kragujevac</b> (1925-2017)	9	4	154.8	192.9	230.6	100.9
<b>Smederevska Palanka</b> (1939-2017)	7	3	168.2	198.2	231.6	94.1
<b>Veliko Gradište</b> (1926-2017)	42	20	129.4	199.0	238.6	179.5

<b>Crni Vrh</b> (1967-2017)	9	9	169.4	223.1	249.3	132.1
<b>Negotin</b> (1927-2016)	23	14	105.8	152.7	188.9	107.4
<b>Zlatibor</b> (1950-2017)	15	8	230.7	285.2	313.0	202.1
<b>Sjenica</b> (1946-2017)	27	9	191.2	208.2	229.3	152.4
<b>Pozega</b> (1952-2017)	35	16	178.0	224.3	238.1	183.4
<b>Kraljevo</b> (1926-2017)	11	5	209.6	233.9	272.7	120.5
<b>Kopaonik</b> (1950-2017)	19	14	224.1	278.5	323.8	<b>218.9</b>
<b>Kursumlija</b> (1952-2017)	45	18	129.2	174.5	208.0	158.6
<b>Krusevac</b> (1927-2017)	22	10	137.0	176.1	209.9	115.5
<b>Cuprija</b> (1948-2017)	9	6	143.8	184.1	204.9	99.5
<b>Nis</b> (1925-2017)	10	5	125.9	147.9	178.7	<b>64.3</b>
<b>Leskovac</b> (1948-2017)	10	5	126.2	155.6	179.6	73.9
<b>Zajecar</b> (1929-2017)	13	6	115.7	159.1	172.8	87.6
<b>Dimitrovgrad</b> (1945-2017)	18	8	150.2	183.6	203.5	123.3
<b>Vranje</b> (1926-2017)	15	8	112.0	151.0	179.9	78.0

\* Rank –period of stations work (lowest seasonal precipitation)

\*\* Rank – 1981-2017 period (lowest seasonal precipitation)

Country	Seasonal temperature JJA		Seasonal precipitation JJA		High Impact Events
	Observed	SEECOF-17 climate outlook for temperature	Observed	SEECOF-17 climate outlook for precipitation	
Serbia (1)	Above normal in entire Serbia	<b>Above-normal</b> (20, 30, 50) in entire Serbia	Below normal in almost entire Serbia	<b>No predictive signal</b> (33, 34, 33) in entire Serbia	<p>* <b>June</b> 2017 was the third warmest for Serbia, second warmest for Novi Sad, Zrenjanin and Cuprija. Zajecar and Sremska Mitrovica observed driest June on record, fourth driest for Serbia</p> <p>* <b>July</b> 2017 ranks as the fourth warmest for Serbia, and the third warmest for Smederevska Palanka and Banatski Karlovac. Zrenjanin observed third driest July while Novi Sad and Crni Vrh experienced fifth driest July. Two heat waves were observed. Record-breaking number of tropical nights was recorded in Zrenjanin.</p> <p>* <b>August</b> 2017 ranks as the third warmest for Belgrade, Cuprija, Novi Sad and Smederevska Palanka, and the seventh warmest for Serbia. Record-breaking number of days with the temperature above 38°C was registered this August. August daily maximum air temperature records were passed in Kikinda, Banatski Karlovac and Zrenjanin. Palic, Sombor, Novi Sad, Zrenjanin, Loznica, Valjevo and Curpija observed record-breaking number of tropical nights. Daily precipitation record was broken at MMS Veliko Gradiste.</p> <p>* The second warmest <b>summer</b> on record for Serbia, and record warm summer in Banatski Karlovac and Smederevska Palanka. The fourth driest for Novi Sad, and the fifth driest for Zrenjanin.</p>

*The second warmest summer on record for Serbia, and record warm summer in Banatski Karlovac and Smederevska Palanka. Dry and very dry across most of Serbia. The fourth driest for Novi Sad, and the fifth driest for Zrenjanin.*

## **Analysis of the 2017 summer season for Serbia compared to the 1981-2010 base period**

### **Temperature**

The mean summer air temperature ranged from 21.0°C in Pozega to 25.4°C in Belgrade, and on the mountains from 14.2°C at Kopaonik to 19.3°C at Zlatibor (*Figure 1*).

Departure of the mean air temperature from the normal<sup>1</sup> during summer, for the 1981-2010 base period ranged from 1.1°C in Zajecar to 3.2°C in Zrenjanin and Belgrade, and in the upland from 1.9°C in Sjenica to 2.5°C at Zlatibor (*Figure 2*).

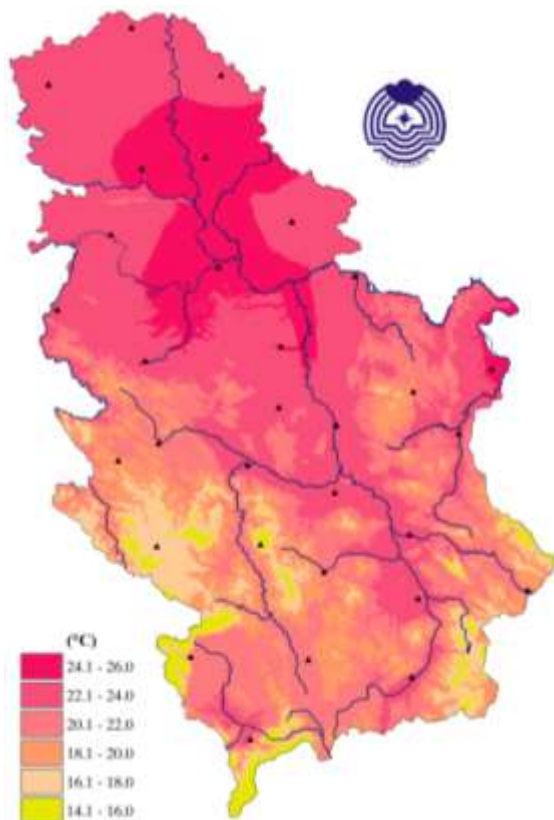


Figure 1. Spatial distribution of the mean seasonal air temperature (°C) during summer

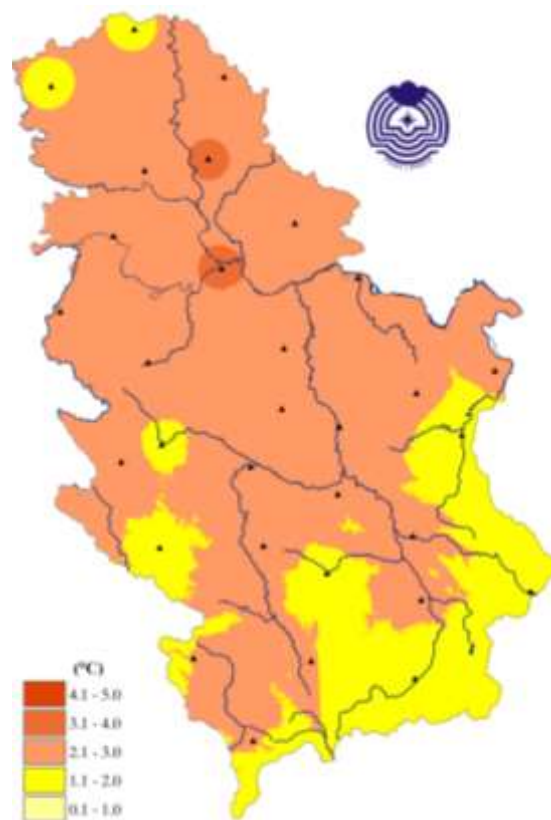


Figure 2. Mean seasonal air temperature anomaly in Serbia during summer compared to the 1981-2010 base period

<sup>1</sup> Term normal refers to climatological standard normal, that is, the average value of a particular climate event, calculated for the period from January 1, 1981 to December 31, 2010



Based on the percentile method<sup>2</sup>, mean summer air temperature in Serbia was in the categories of extremely warm and very warm (*Figure 3*).

Based on the tercile method, mean summer air temperature in Serbia was in the warm category (*Figure 4*).

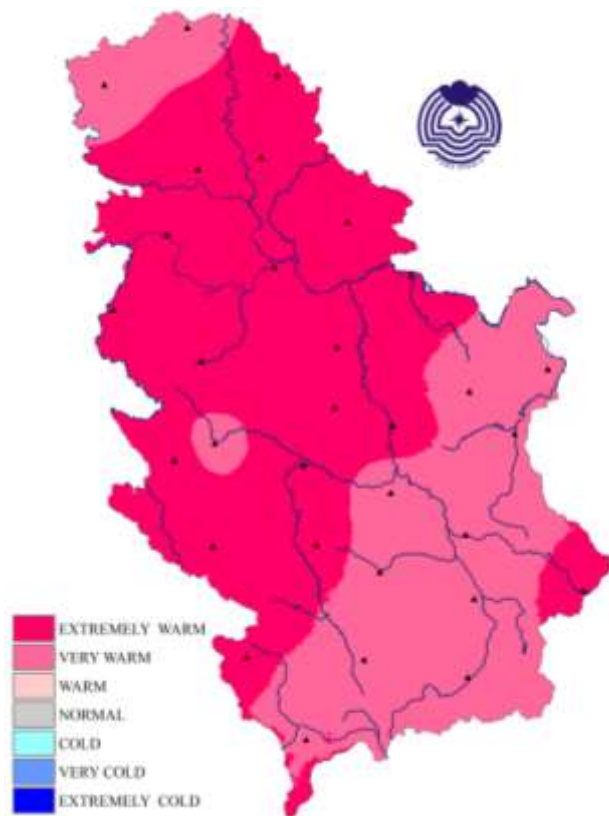


Figure 3. Air temperature assessment in Serbia during summer using percentile method compared to the 1981-2010 base period

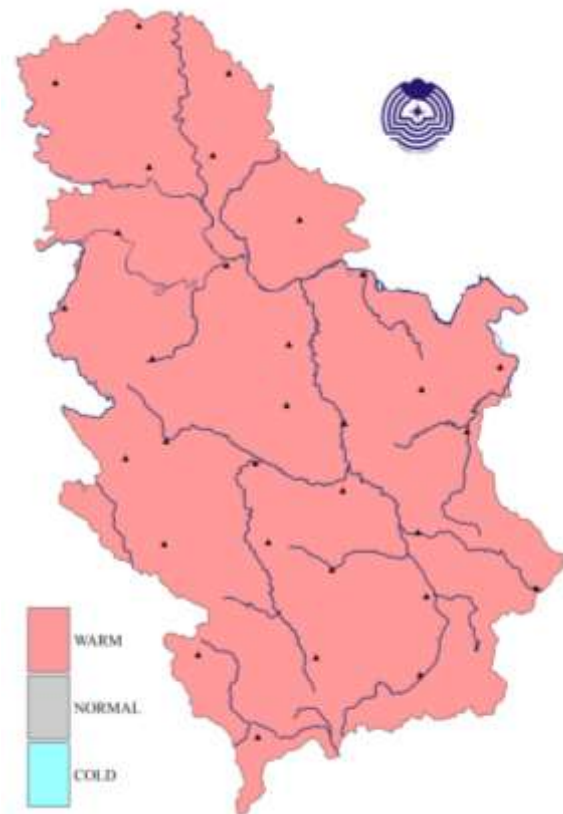


Figure 4. Air temperature assessment in Serbia during summer using tercile method compared to the 1981-2010 base period

Summer of 2017 was the second warmest for Serbia with the mean air temperature of 22.5°C. The warmest summer in Serbia was the summer of 2012 with the mean air temperature of 23.3°C (*Figure 5*). Belgrade observed its second warmest summer with the air temperature of 25.4°C, after the summer of 2012 when seasonal air temperature of 26.0°C was registered.

The summer of 2017 was record warm in Banatski Karlovac and Smederevska Palanka with the mean seasonal air temperature of 23.7°C and 24.0°C, respectively (*Figure 6*).

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<sup>2</sup>nth percentile of a variable refers to the value of the observed variable below which there is n percent of data previously arranged in an ascending order

Rank of coldest and warmest summer seasons in Serbia for 1951-2017 period

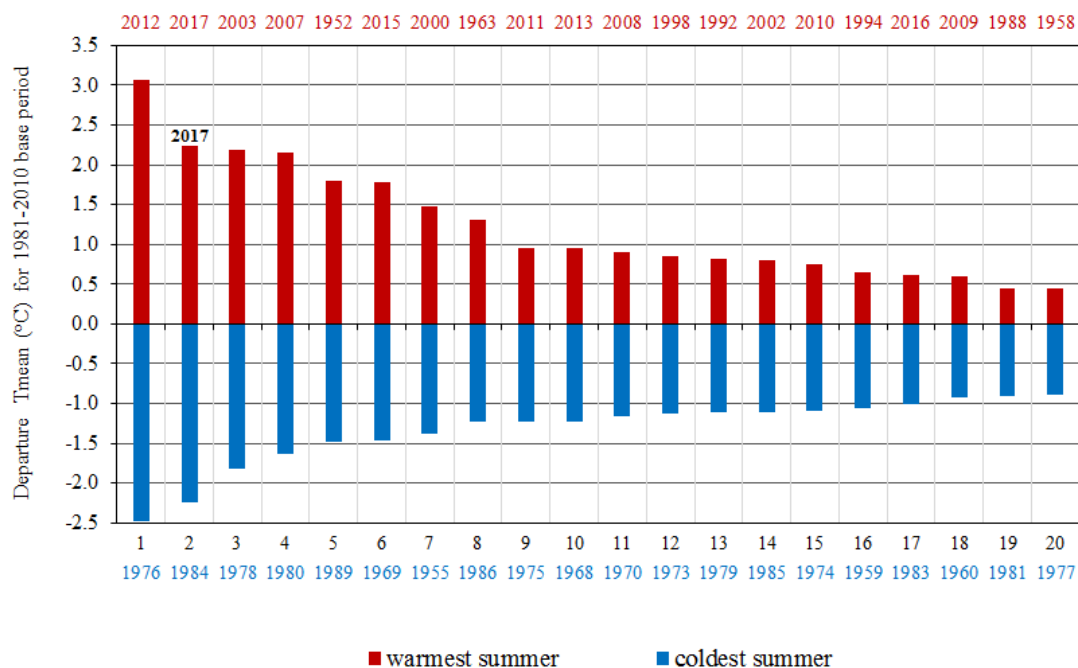


Figure 5. Rank of the warmest and coldest summer seasons in Serbia for the 1951-2017 period

Departure of the mean seasonal air temperature from 1981-2010 base period  
Smederevska Palanka 1939-2017 period

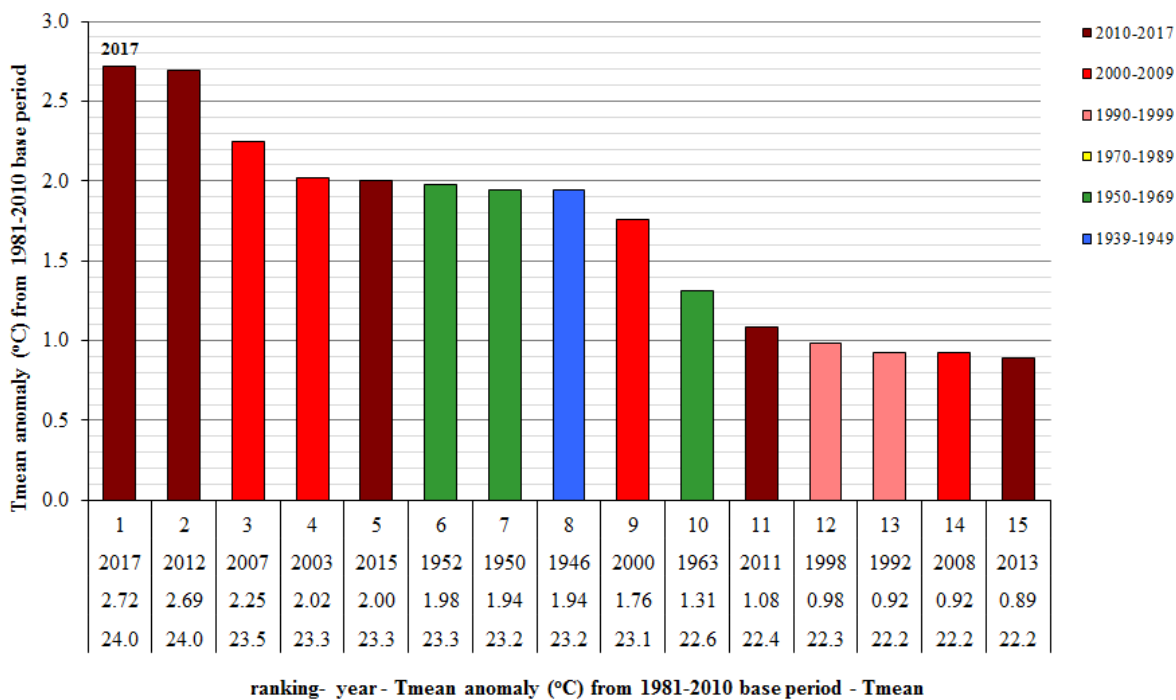


Figure 6. Ranking of the 15 warmest summer seasons on record in descending order in Smederevska Palanka for the 1939-2017 period

The number of summer days<sup>3</sup> ranged from 75 in Pozega and Kursumlija to 87 in Zrenjanin, Veliko Gradiste and Negotin. And on the mountains, their number ranged from 8 days at Kopaonik to 54 in Sjenica, which is 22 days above the average. Belgrade observed 85 summer days, which is 17 days above the average (*Figure 7*).

The number of tropical days<sup>4</sup> ranged from 42 on Palic to 61 days in Negotin. As for the upland, the greatest number of tropical days, total of 12, was registered in Sjenica, which is 12 days above the average. Belgrade observed 55 tropical days, which is 23 days above the average (*Figure 8*).

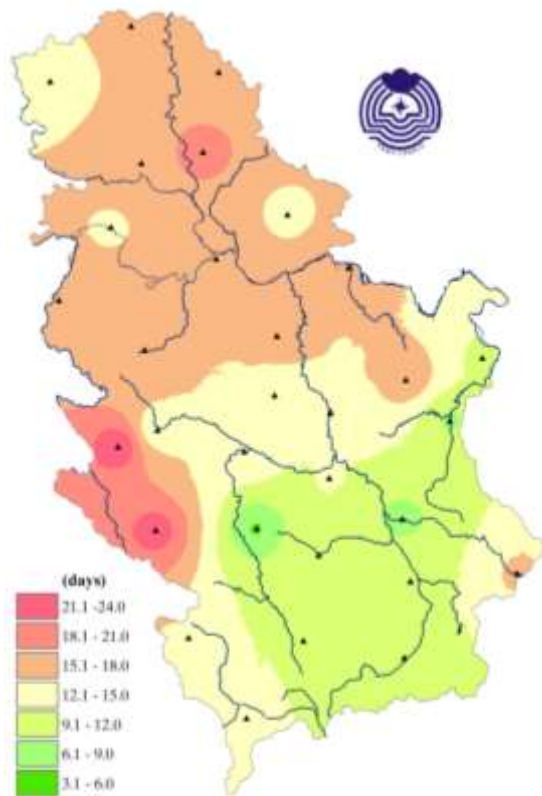


Figure 7. Deviation of the number of summer days compared to the normal 1981-2010

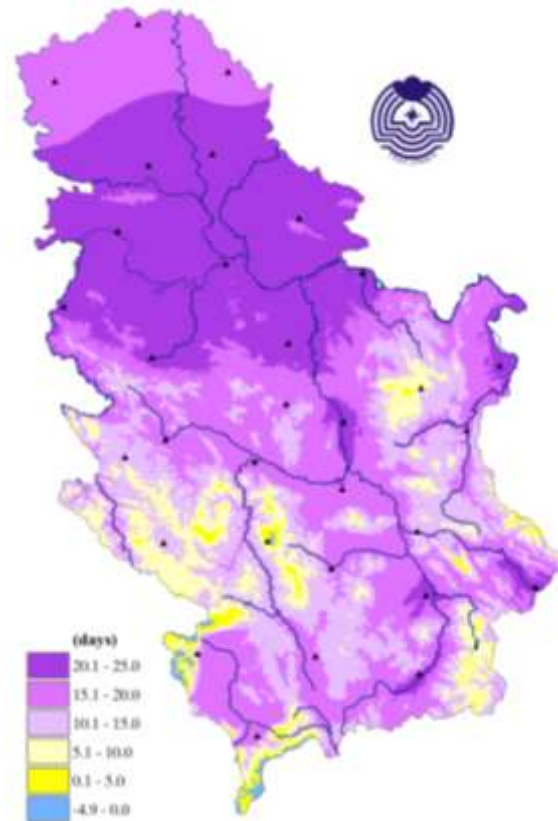


Figure 8. Deviation of the number of tropical days during summer compared to the normal 1981-2010

The greatest number of tropical nights<sup>5</sup> was recorded in Belgrade, total of 39 nights, which is 23 days above the average for Belgrade. Record-breaking number of tropical nights was observed in Zrenjanin, Novi Sad, Banatski Karlovac and Cuprija. In summer 2017, Zrenjanin observed 25 tropical nights, besting the previous record of 18 nights recorded in summer 2015. Novi Sad experienced 15 tropical nights, breaking the previous record of 10 nights from 2010 and 2012. The previous record of 10 tropical nights from 2007 and 2010 in Banatski Karlovac was surpassed in summer 2017 with 13 nights. Cuprija observed 9 tropical nights besting the previous record of 6 nights from 1963 and 1988.

<sup>3</sup>Summer day is defined as the day with the maximum air temperature of 25°C and above

<sup>4</sup>Tropical day is defined as the day with the maximum air temperature of 30°C and above

<sup>5</sup>Tropical nights is defined as the day with the daily air temperature of 20°C and above

The highest daily air temperature of 41.6°C during summer 2017 was measured in Cuprija on August 6.

The lowest summer air temperature of 1.3°C was measured in Sjenica on August 23.

Most of the summer period, mean, maximum and minimum air temperature was above the multiannual average. Warm periods were equally interrupted by abrupt changes caused by incursions of the colder air masses. The colder periods lasted shortly, so that 4 out of 8 brought considerable cooling (*Figure 9*). Leskovac observed cold wave, lasting from August 22 to 26.

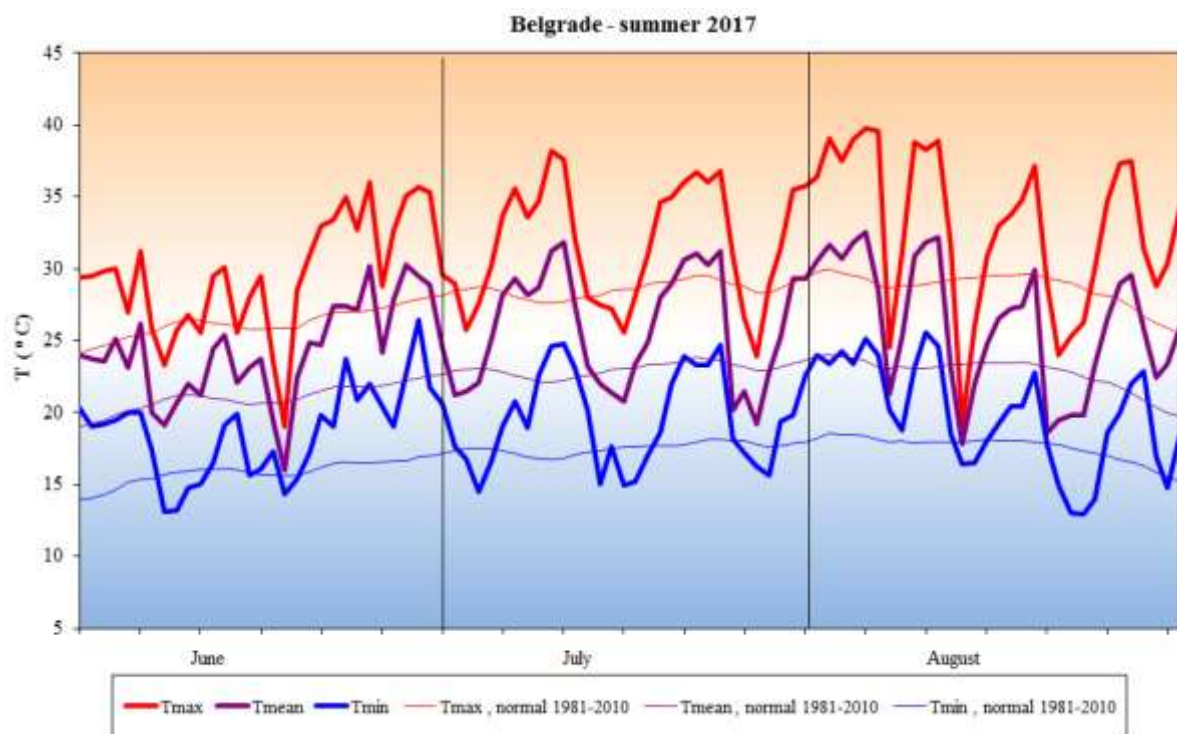


Figure 9. Three-month course of the mean, maximum and minimum air temperature in Belgrade

Figures 10, 11 and 12 show three-month course of the mean daily air temperature for Belgrade, Kopaonik and Nis.

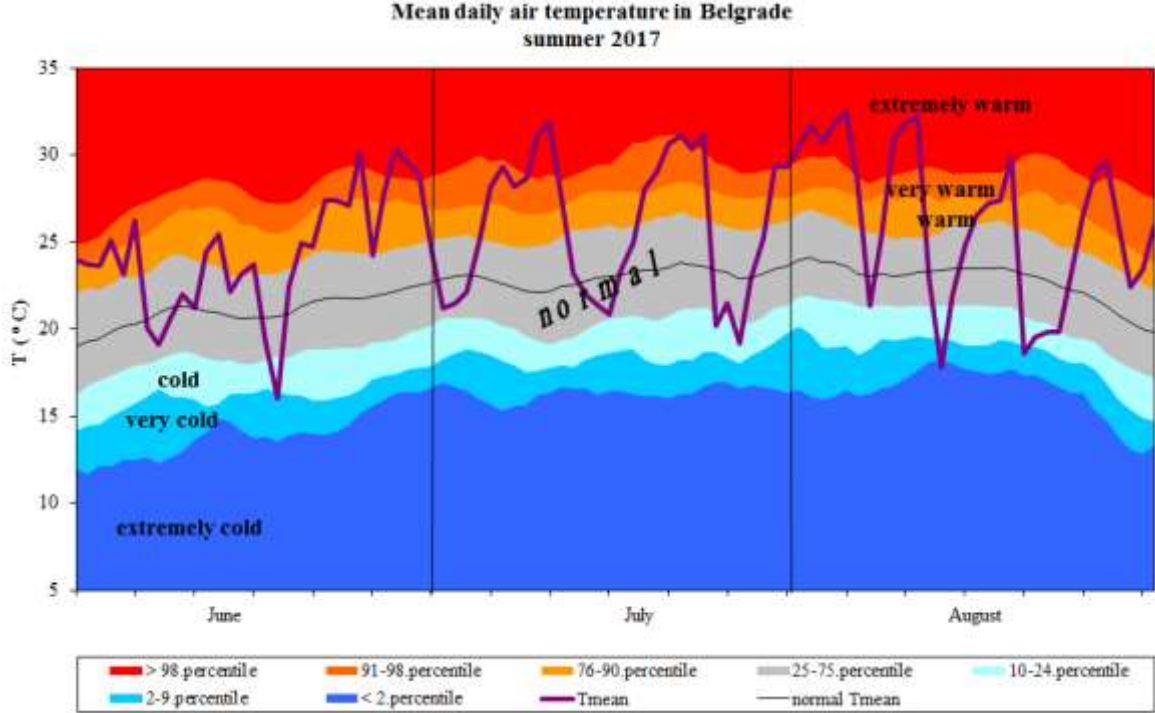


Figure 10. Three-month course of the mean daily air temperature in Belgrade

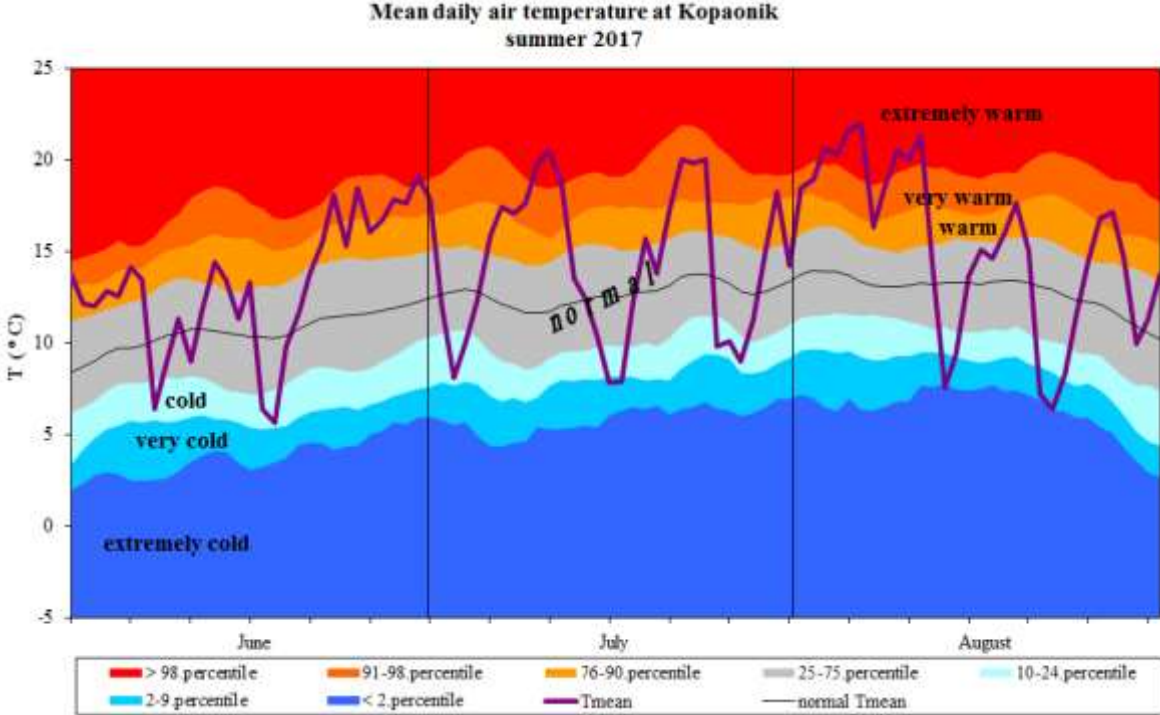


Figure 11. Three-month course of the mean daily air temperature at Kopaonik

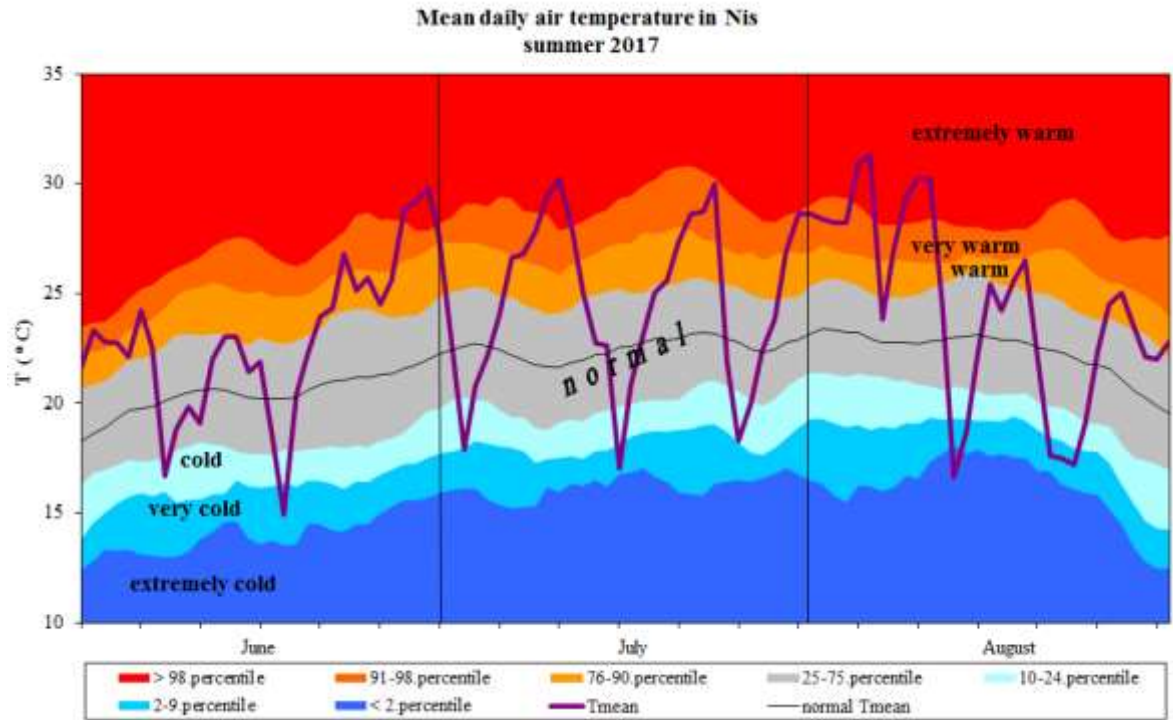


Figure 12. Three-month course of the mean daily air temperature in Nis

Figure 13 shows the assessment of the air temperature and precipitation sums for Serbia for the summer season (June, July and August) based on the tercile distribution compared to the 1981-2010 base period. The summer 2017 is marked by warm and dry conditions, that is air temperature in the upper tercile and precipitation sums in the lower tercile.

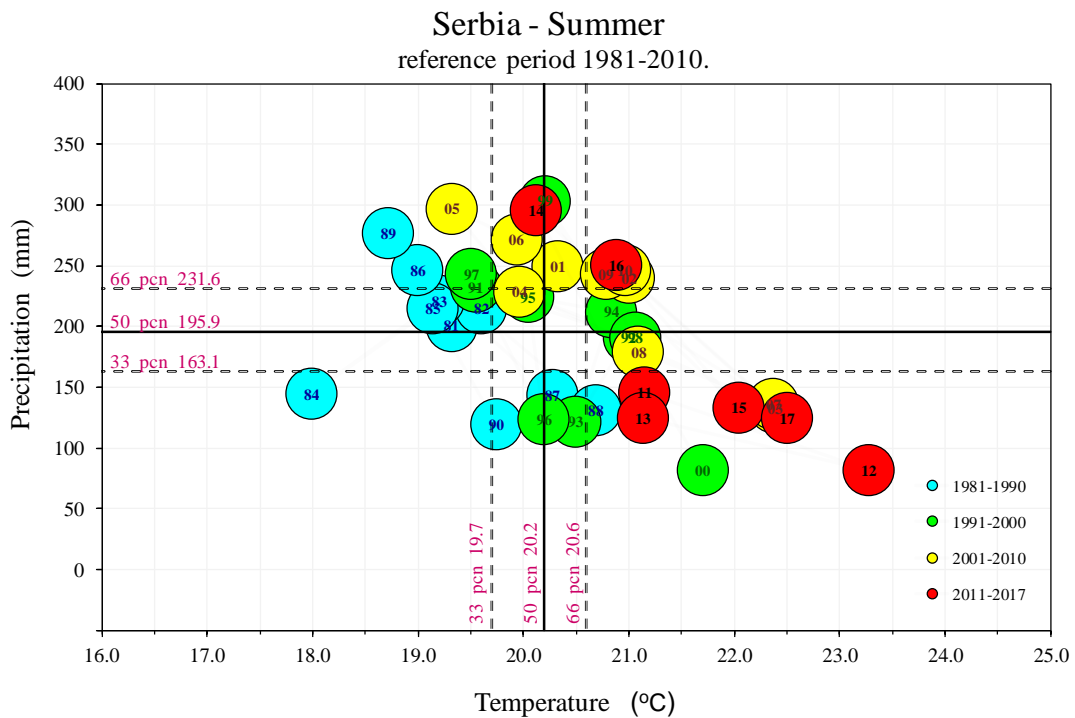


Figure 13. Assessment of air temperature and precipitation for summer in Serbia with the accompanying terciles relative to the 1981-2010 base period

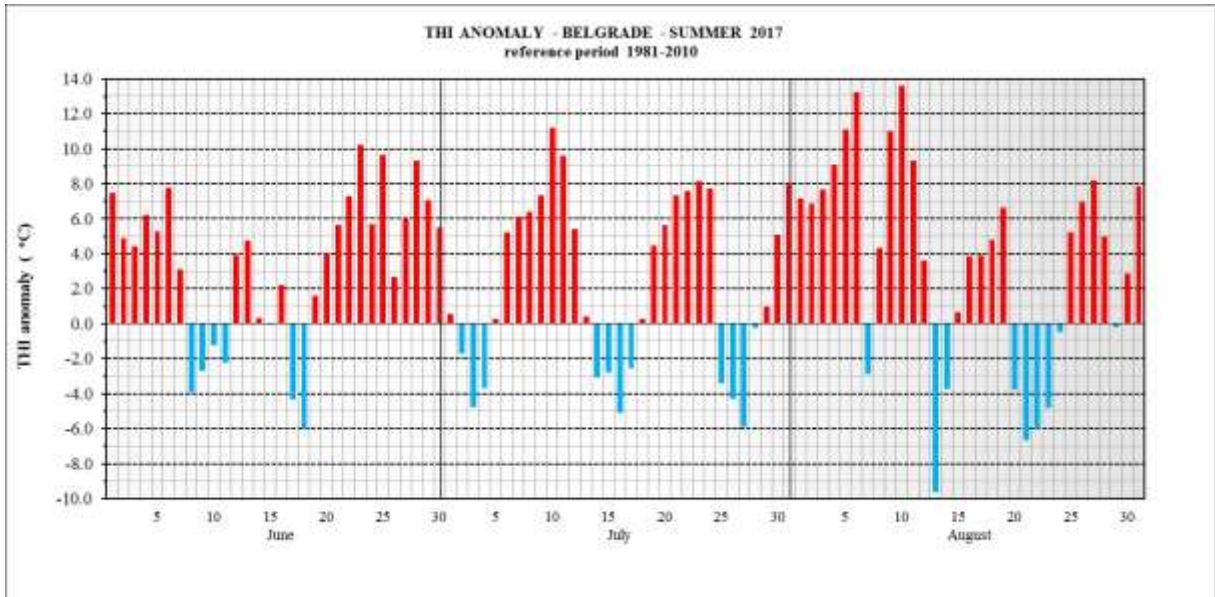


Figure 14.

Departure of the Temperature Heat Index (THI)<sup>6</sup> was positive most of the summer (Figure 14). The greatest difference between the apparent temperature (feels like temperature) and the maximum daily air temperature was observed during the first half of August (Figure 15), measuring 7.6°C on August 10. The maximum air temperature of 38.3°C was measured that day, nevertheless the feels like temperature was 45.9°C which is at the same time the highest summer 2017 value.

There was in total fifteen days with THI above 40°C, and 67 days with the temperature above 30°C.

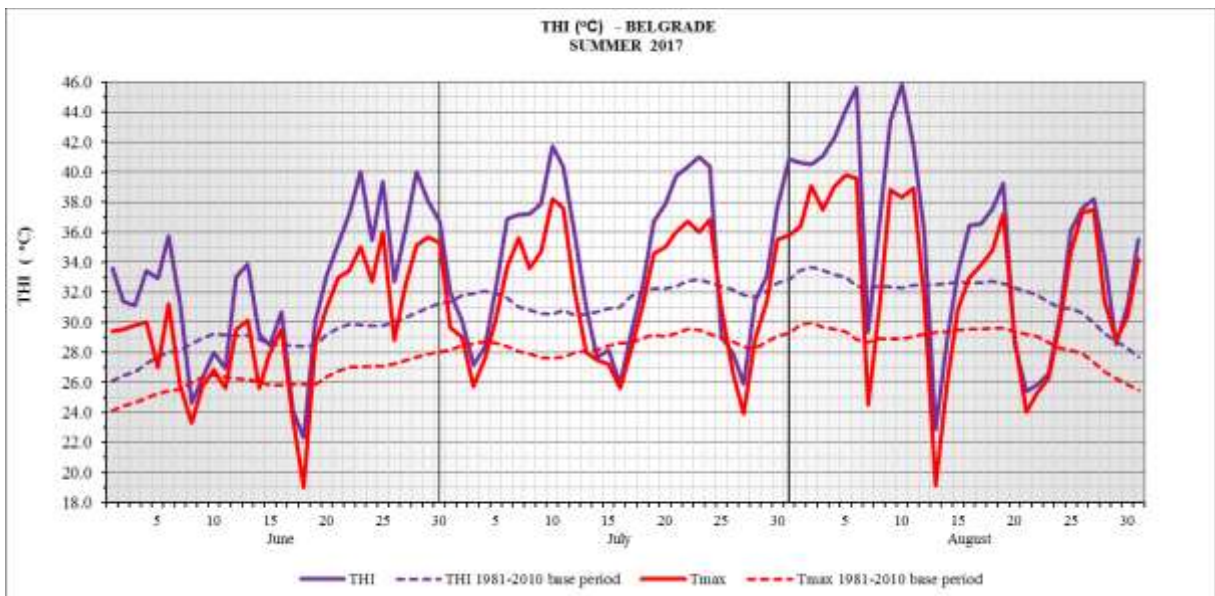


Figure 15

<sup>6</sup> THI is defined as the unit of subjective sensation of warmth, that is, unit of relative discomfort due to the prolonged exposure to extremely warm and wet weather, indicating likelihood of heatstroke, sun stroke or other acute body stress symptoms.

## Heat waves during summer 2017

During summer of 2017, six heat waves<sup>7</sup> were recorded. The first heat wave was registered between June 20 and 25 in Sombor, Zrenjanin, Novi Sad, Sremska Mitrovica and Palic, and the second one from June 27 to July 1 in Negotin. Third heat wave was observed in the period from July 6 to 12 across most of Serbia, and the fourth, lasting from July 19 to 24 in Kikinda, Zrenjanin, Belgrade, Veliko Gradiste, Smederevska Palanka and Banatski Karlovac. Fifth heat wave was recorded in the entire country, apart from Zajecar, in the period from July 30 to August 6, and the sixth one lasted from August 8 to 12 in Vranje, Dimitrovgrad and Kopaonik.

Figure 16 shows spatial distribution of the heat wave intensity<sup>8</sup> during summer 2015 in Serbia.

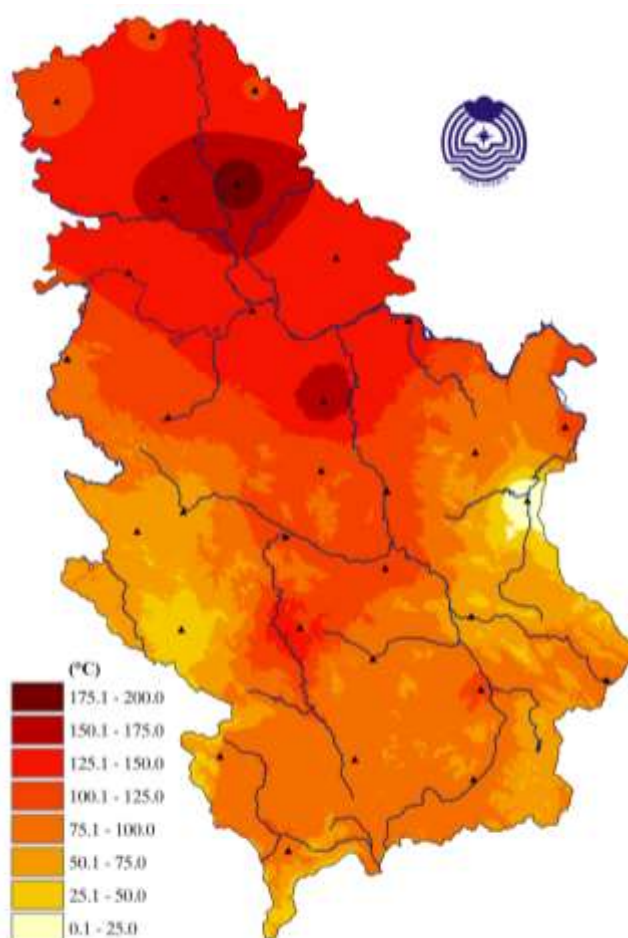


Figure 16.

<sup>7</sup> Heat wave is defined as a period of at least 5 consecutive days during which the maximum temperature falls under the very warm and extremely warm category

<sup>8</sup> Heat wave intensity indicates sum of the maximum air temperature departure from the mean maximum air temperature for the climatological base period





## Precipitation

The entire country observed below-average summer precipitation sums compared to the normal for the 1981-2010 base period. Compared to the normal, precipitation sums ranged from 38% in Zrenjanin to 91% in Kursumlija (*Figure 17*).

Based on the percentile method, summer precipitation sums were in the dry and very dry category across most of Serbia, and extremely dry in Zrenjanin (*Figure 18*).

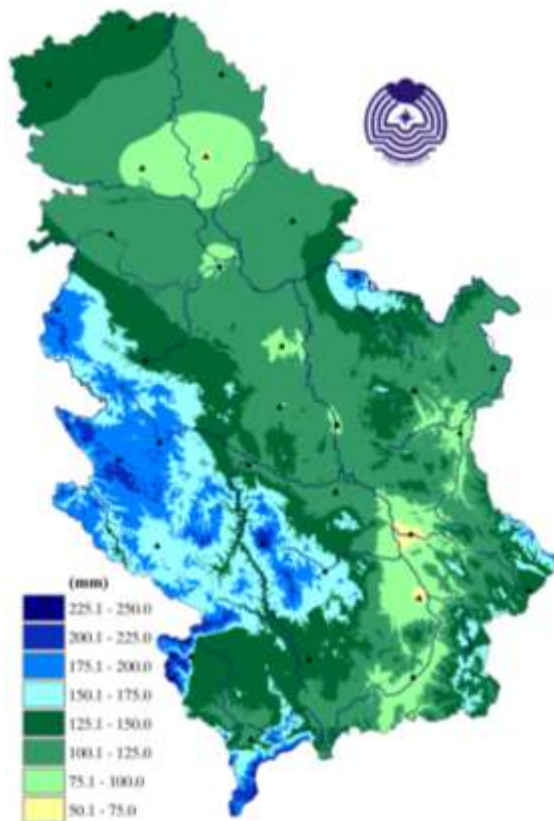


Figure 17. Spatial distribution of the precipitation sums expressed in the percentages of normal 1981-2010 during summer

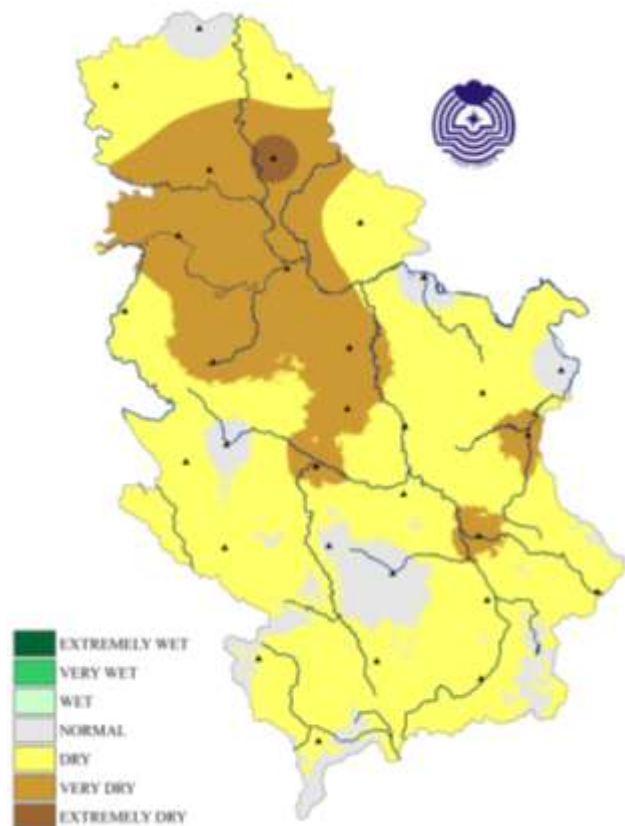


Figure 18. Precipitation sums assessment using percentile method during summer compared to the 1981-2010 base period

Based on the tercile method, precipitation sums were below the average across most of Serbia (Figure 19).

The maximum daily precipitation total of 80.4 mm was registered in Veliko Gradiste on July 13 thereby besting the previous August precipitation record of 71.6 mm set on August 28, 1985.

The number of days with precipitation was from 4 to 14 days below the summer average. The fewest days with precipitation was in Negotin, total of 14 days, whereas Kopaonik observed the highest number, total of 30 days. The number of days with precipitation of 1mm and above was below the average, while the highest departure of 12 days was recorded in Smederevska Palanka and Cuprija (Figure 20).

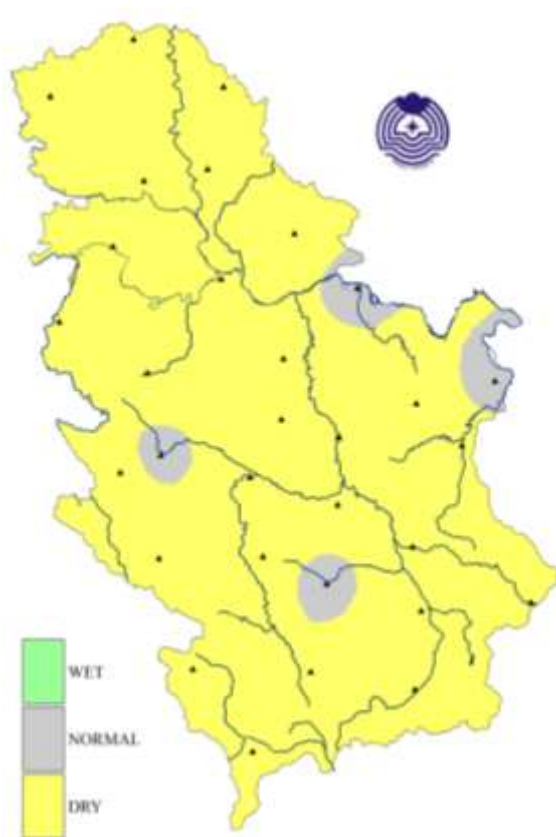


Figure 19. Precipitation sums assessment using tercile method during summer compared to the 1981-2010 base period

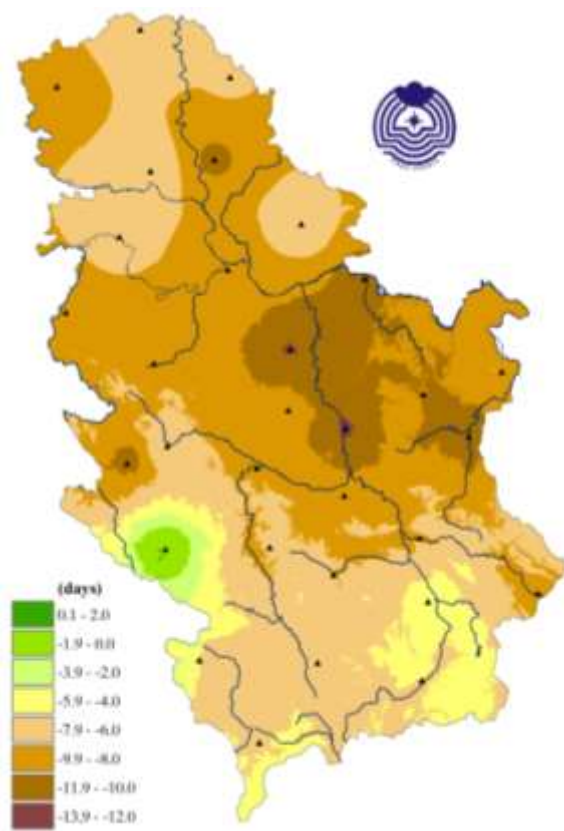


Figure 20. Deviation of the number of days with precipitation from 1mm and above during summer

Based on the analysis of the wettest and driest summer in Serbia for the 1951-2017 period, it can be noted that the summer of 2017 ranks as the tenth driest summer for Serbia (Figure 21).

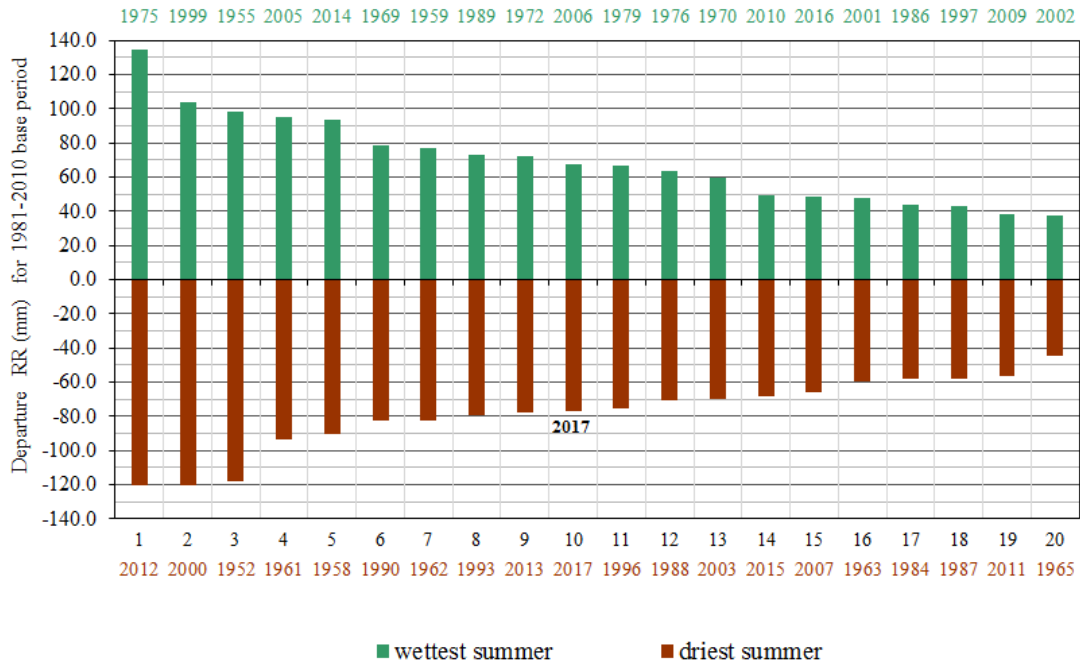


Figure 21. Rank of the wettest and driest summer seasons in Serbia for the 1951-2017 period

Novi Sad experienced its fourth driest summer on record after the summer of 2000, 2012 and 1950 (Figure 22). Zrenjanin observed its fifth driest summer after the summer of 2000, 1962, 1928 and 1952.

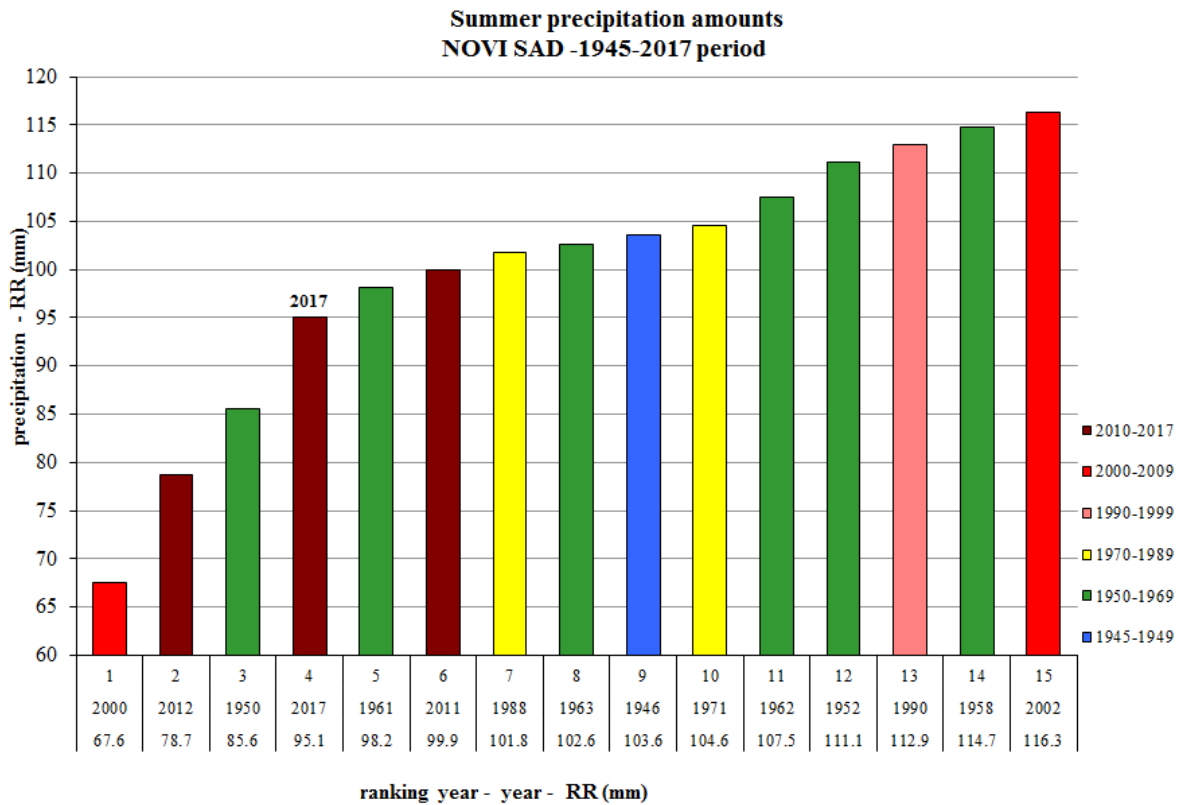


Figure 22. Summer precipitation sums for Novi Sad in the 1945-2017 period in the ascending order (15 years out of series with the lowest summer precipitation sums)

Figures 23 and 24 show summer cumulative precipitation sums per month compared to the average cumulative precipitation sums for Belgrade and Zrenjanin.

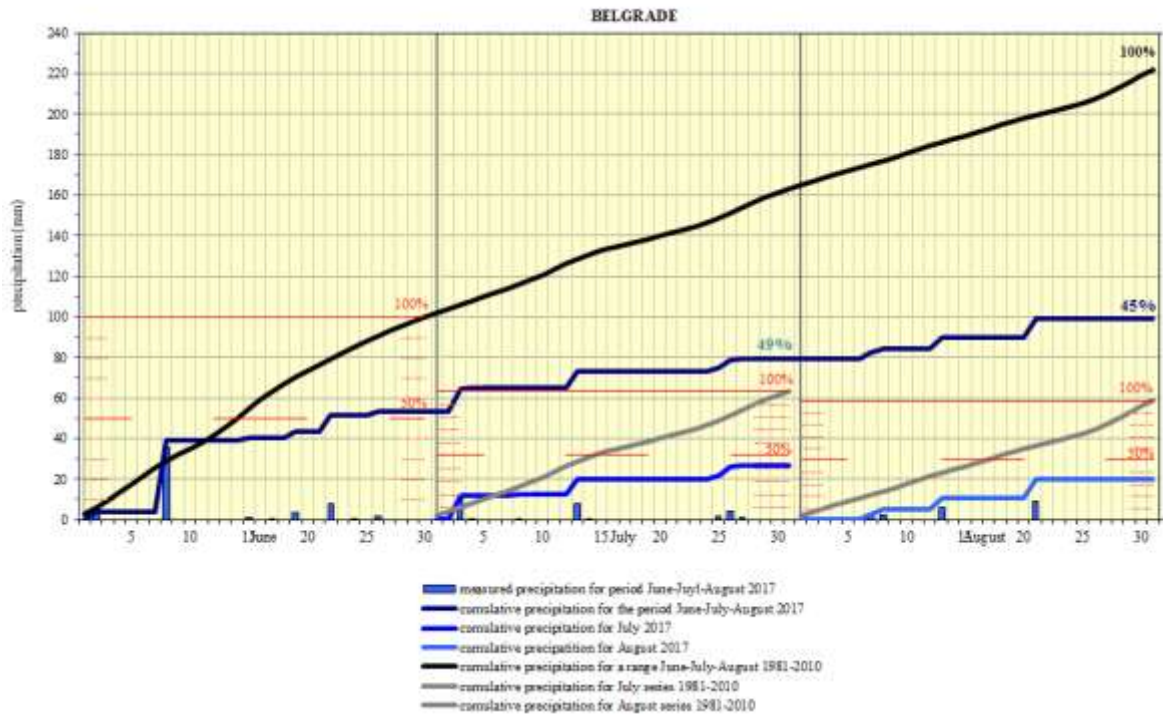


Figure 23. Cumulative precipitation sums in Belgrade

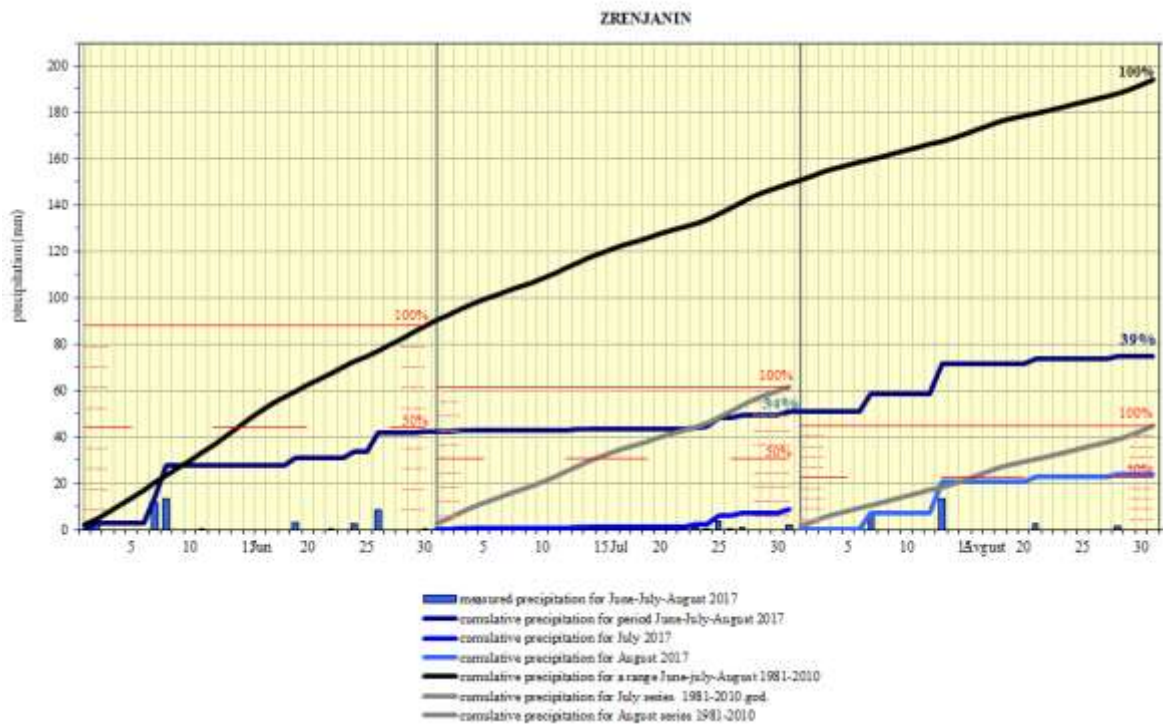


Figure 24. Cumulative precipitation sums in Zrenjanin

## Sunshine duration (insolation)

In summer, sunshine duration was within the average across most of Serbia, and above the average in Pozega, Krusevac and Kraljevo. Insolation values ranged from 806.3 in Zajecar to 1035.1 in Novi Sad (Figure 25).

Insolation ranged from 100% in Zajecar to 140% in Pozega compared to the normal for the 1981-2010 base period (Figure 26).

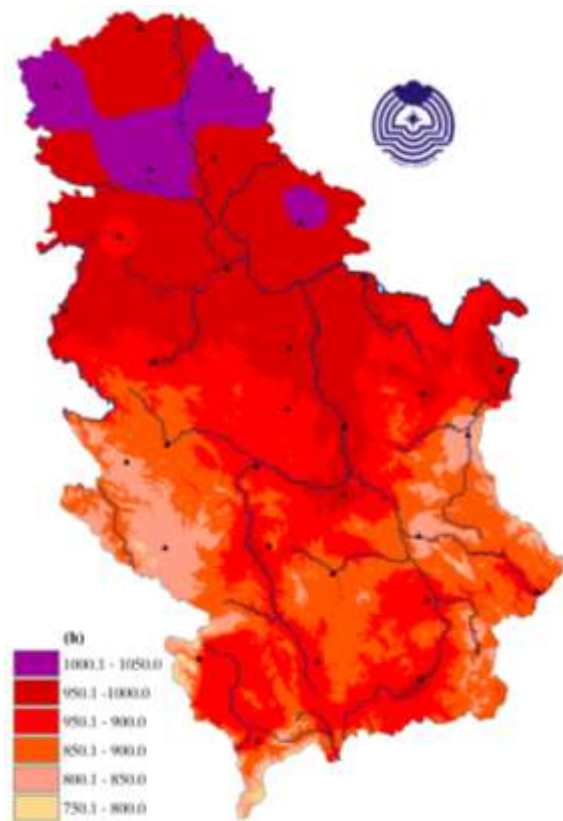


Figure 25. Insolation expressed in hours during summer

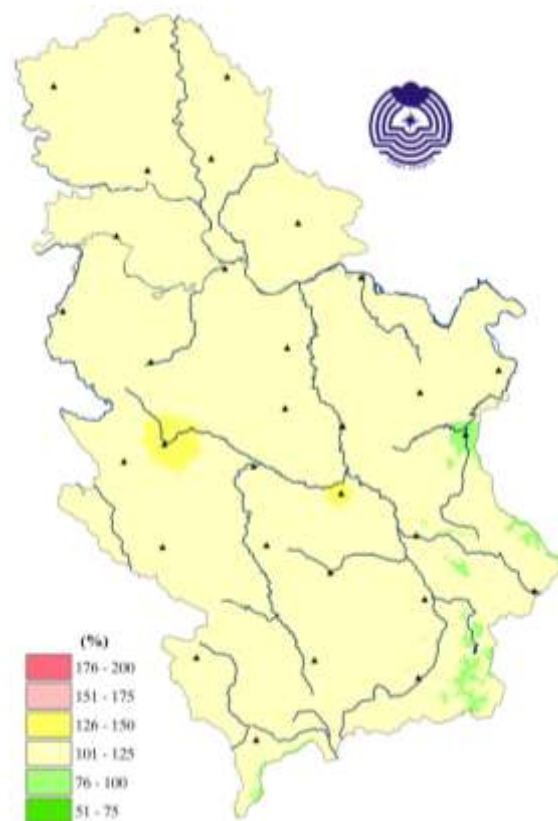


Figure 26. Insolation expressed in hours during summer

# Analysis of the 2017 summer season for Serbia compared to the 1961-1990 base period

## Temperature

In summer, departures of the mean air temperature from the normal for the 1961-1990 base period were in a range from 2.4°C in Pozega to 4.4°C in Belgrade, and on the mountains from 3.0°C in Sjenica to 3.6°C at Zlatibor and Kopaonik (Figure 27).

Based on the percentile method, mean air temperature was in the extremely warm category across the entire country (Figure 28).

Based on the tercile method, mean air temperature was above the average in entire Serbia.

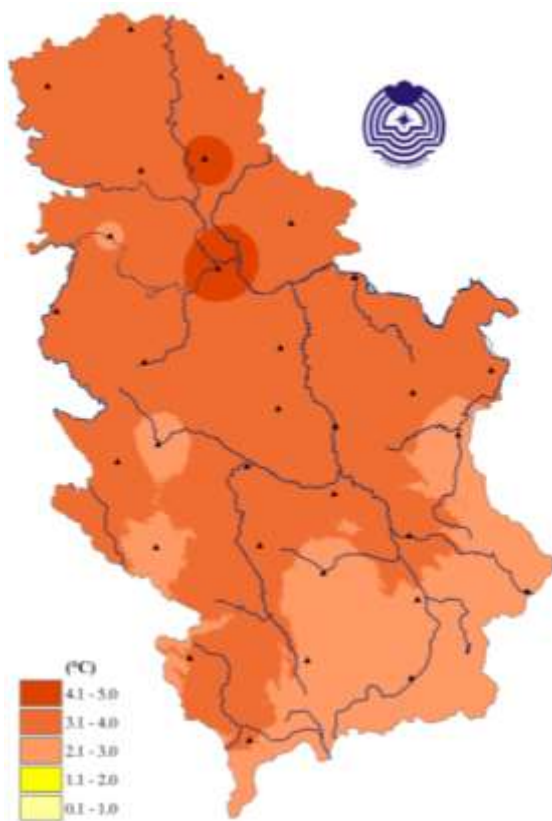


Figure 27. Seasonal mean air temperature anomaly compared to the 1961-1990 base period

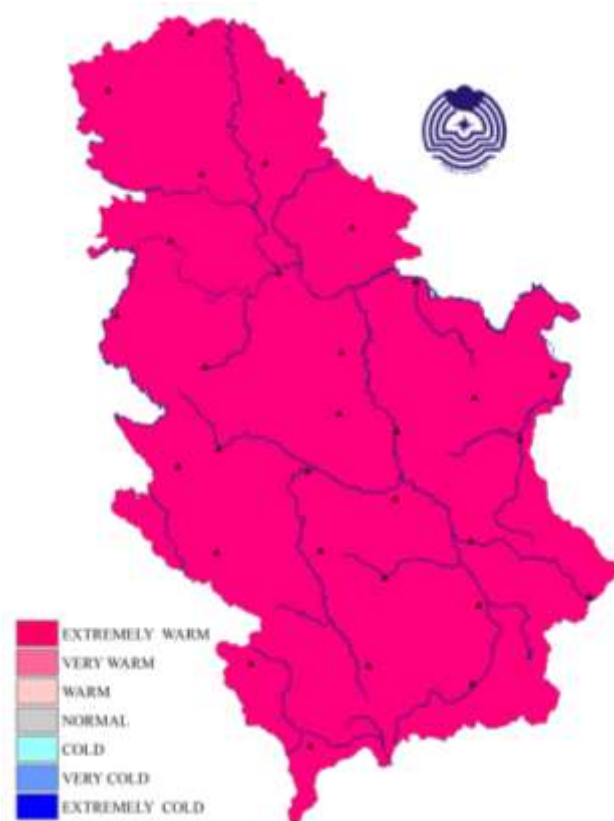


Figure 28. Assessment of the air temperature in Serbia using percentile method compared to the 1961-1990 base period

## Precipitation

Summer precipitation sums were below average across most of Serbia compared to the normal for the 1961-1990 base period. Precipitation sums compared to the normal were in a range from 40% in Zrenjanin to 90% in Kursumlija (*Figure 29*).

Based on the percentile method, summer precipitation sums were in the following categories: dry category in most of Serbia, extremely dry in Novi Sad, Zrenjanin, Kraljevo and Nis, and dry in Loznica, Sjenica, Krusevac, Palic, Zlatibor and Kopaonik. Summer precipitation sums were in the normal category in Veliko Gradiste, Negotin, Pozega and Kursumlija (*Figure 30*).

Based on the tercile method, precipitation sums were below the average across most of Serbia, and within average in Velikoi Gradiste and Kursumlija.

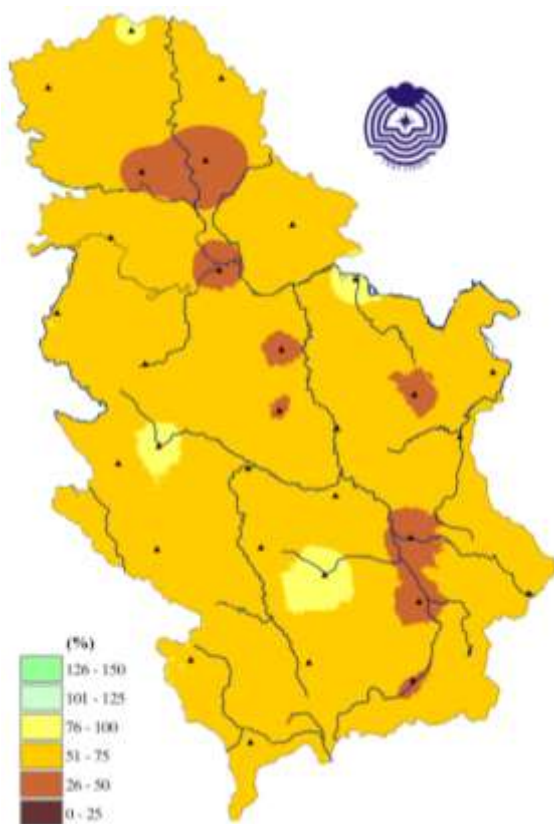


Figure 29. Spatial distribution of precipitation sums expressed in the percentages of normal compared to the 1961-1990 base period

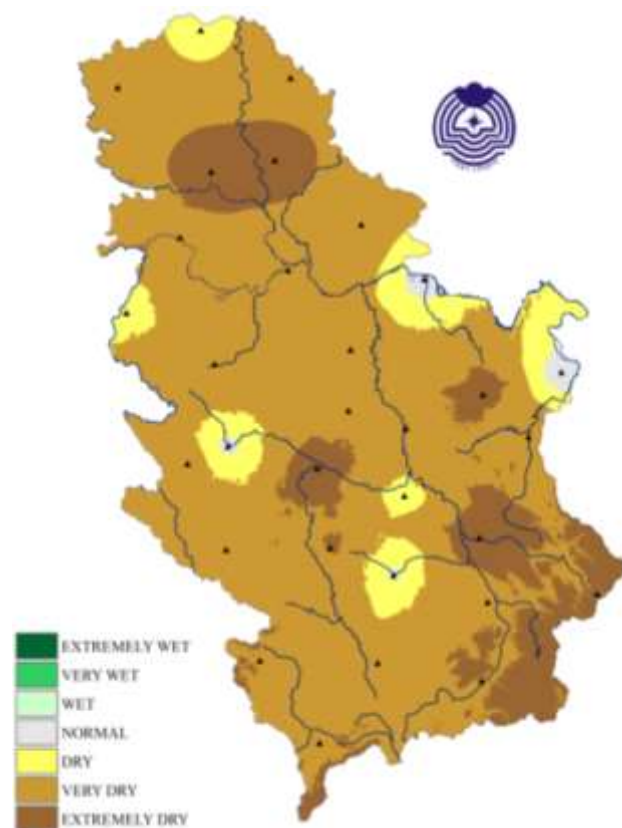


Figure 30. Assessment of the precipitation sums using percentile method compared to the 1961-1990 base period