VERIFICATION OF THE SEECOF–25 SUMMER 2021 CLIMATE OUTLOOK AND SEASONAL BULLETIN FOR THE TERRITORY OF SERBIA

Belgrade, 10 October 2021

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Temperature

The SEECOF-25 outlook for the summer 2021 in Serbia indicated warmer than normal temperature in Serbia with 50% probability relative to the 1981–2010 climatological base period (*Figure* A).

Climatological monitoring showed that the summer 2021 was warm in entire Serbia, with above-normal temperature based on the tercile method (*Figure* B). The outlook for a warm summer was correct in entire Serbia.

OUTLOOK – SUMMER **2021**

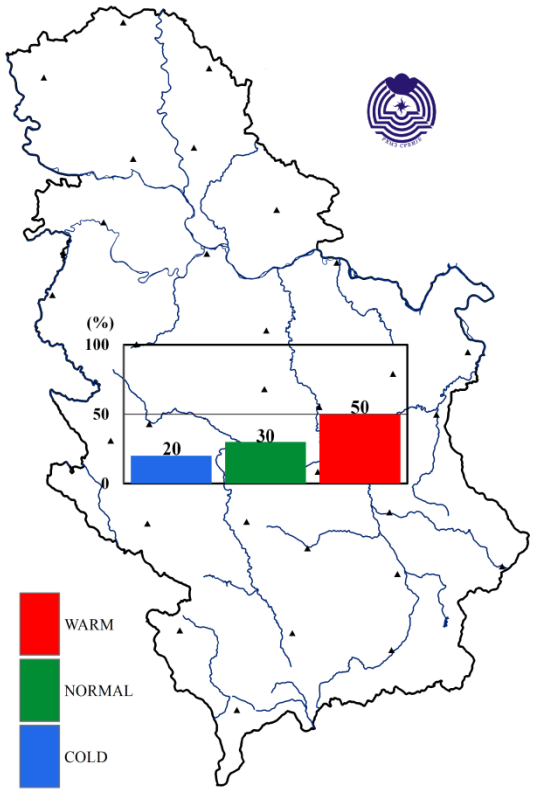


Figure A. SEECOF-25 - summer temperature outlook

MONITORING – SUMMER **2021**

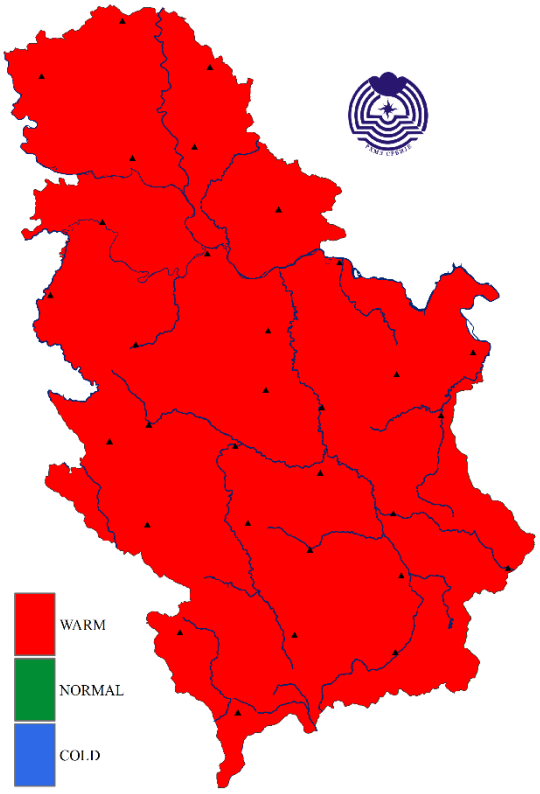


Figure B. Monitoring of the summer temperature using tercile method compared to the 1981-2010 base period

Precipitation

According to the SEECOF-25 outlook for the summer 2021 approximately equal probabilities for below, near or above normal precipitation for Serbia were indicated, relative to the 1981–2010 climatological base period (*Figure* C), therefore climatology (average seasonal precipitation) was suggested.

Based on the climatological monitoring of precipitation, the summer of 2021 was normal and below normal in most of Serbia. Above average precipitation were at some locations in central and northwestern Serbia (*Figure* D). The outlook for a normal summer was correct for some parts of Serbia.

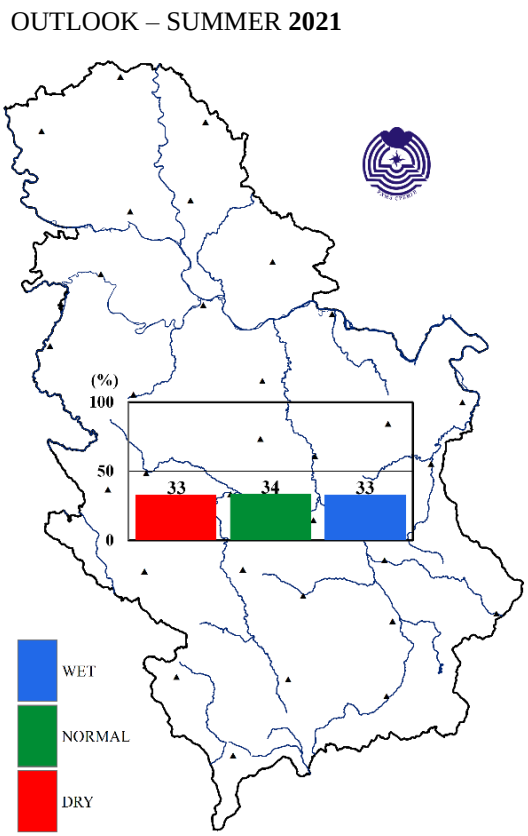


Figure C. SEECOF-25 - summer precipitation outlook

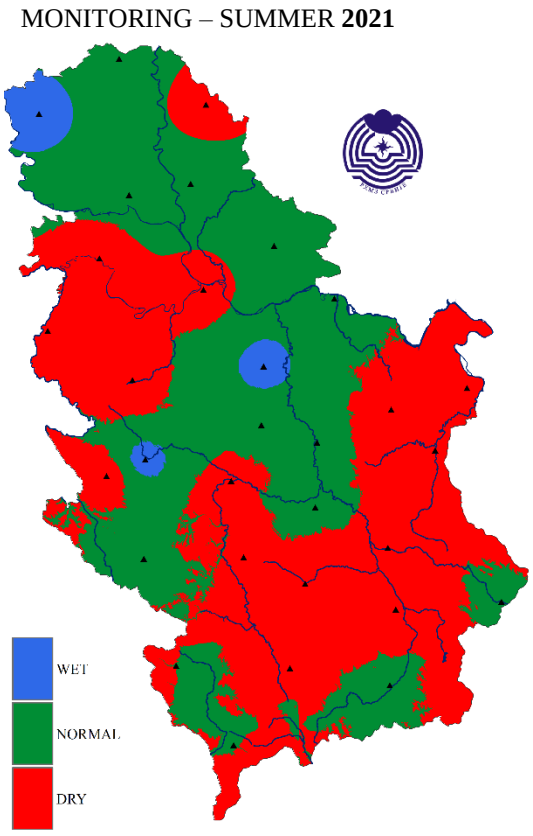


Figure D. Monitoring of the summer precipitation using tercile method compared to the 1981-2010 base period

Summer 2021			Air Temperature (°C)			
Station	Rank*	Rank**	33	50	66	Observed value
Beograd (1888-2021)	**3**	**3**	21.6	22.0	22.9	**24.9**
Palić (1945-2021)	5	5	20.9	21.3	21.9	**23.4**
Sombor (1942-2021)	9	6	20.6	21.0	21.3	**22.7**
Novi Sad (1948-2021)	5	5	20.8	21.0	21.6	**23.6**
Zrenjanin (1946-2021)	8	6	21.0	21.2	21.7	**23.5**
Kikinda (1948-2021)	4	4	20.8	21.3	21.7	**23.7**
Banatski Karlovac (1986-2021)	7	7	20.9	21.3	21.8	**22.9**
Loznica (1952-2021)	4	4	20.7	21.0	21.7	**23.3**
Sremska Mitrovica (1925-2021)	8	5	20.5	20.8	21.2	**22.9**
Valjevo (1926-2021)	4	**3**	20.5	20.9	21.6	**23.7**
Kragujevac (1925-2021)	10	5	20.6	21.2	21.6	**22.9**
Smederevska Palanka (1939-2021)	10	7	20.8	21.3	21.8	**23.1**
Veliko Gradište (1926-2021)	10	7	20.4	21.1	21.4	**22.9**
Crni Vrh (1967-2021)	4	4	15.9	16.3	16.6	**18.5**
Negotin (1927-2021)	7	**3**	22.0	22.7	23.1	**24.8**
Zlatibor (1950-2021)	4	4	16.3	16.8	17.3	**19.3**
Sjenica (1946-2021)	4	4	15.3	15.9	16.2	**17.5**
Pozega (1952-2021)	8	7	18.9	19.4	19.5	**20.6**
Kraljevo (1926-2021)	6	4	20.6	21.0	21.5	**23.2**
Kopaonik (1950-2021)	**3**	**3**	11.5	12.1	12.5	**14.3**
Kursumlija (1952-2021)	4	4	19.0	19.4	19.9	**21.4**
Krusevac (1927-2021)	10	5	20.7	21.1	21.5	**22.8**

Cuprija (1948-2021)	5	4	20.3	21.0	21.3	**23.1**
Nis (1925-2021)	12	7	21.2	21.9	22.2	**23.4**
Leskovac (1948-2021)	7	5	20.4	20.9	21.1	**22.7**
Zajecar (1929-2021)	11	6	20.9	21.8	22.0	**22.5**
Dimitrovgrad (1945-2021)	7	4	18.8	19.4	19.7	**21.2**
Vranje (1926-2021)	13	7	20.3	21.1	21.3	**22.6**

*Rank –period of stations work (warmest season)

**Rank – 1981-2021 period (warmest season)

Summer 2021			Precipitation sums (mm)			
Station	Rank*	Rank**	33	50	66	Observed Value
Beograd (1888-2021)	25	8	169.3	222.8	264.1	**135.5**
Palić (1945-2021)	37	18	161.4	197.6	219.0	**170.5**
Sombor (1942-2021)	77	34	180.2	187.8	215.1	**263.1**
Novi Sad (1948-2021)	34	19	174.5	187.8	236.8	**184.7**
Zrenjanin (1946-2021)	54	24	155.3	175.6	222.8	**180.8**
Kikinda (1948-2021)	25	11	152.4	174.9	205.7	**129.1**
Banatski Karlovac (1946-2021)	38	20	146.6	198.6	246.0	**189.4**
Loznica (1926-2021)	16	7	237.8	256.5	309.0	**152.2**
Sremska Mitrovica (1925-2021)	27	12	173.9	189.4	226.1	**143.2**
Valjevo (1926-2021)	11	5	214.0	233.9	286.7	**134.6**
Kragujevac (1925-2021)	38	18	154.8	195.4	230.6	**172.7**
Smederevska Palanka (1939-2021)	70	30	168.2	201.5	231.6	**254.9**
Veliko Gradište (1926-2021)	58	26	129.4	173.9	238.6	**224.4**

Crni Vrh (1967-2021)	11	11	169.4	196.9	249.3	**138.1**
Negotin (1927-2021)	13	9	105.8	138.2	188.9	**79.6**
Zlatibor (1950-2021)	**4**	**3**	230.7	288.4	313.0	**127.4**
Sjenica (1946-2021)	48	19	191.2	213.6	229.3	**212.7**
Pozega (1952-2021)	64	29	178.0	218.5	238.1	**260.8**
Kraljevo (1926-2021)	21	12	209.6	244.4	272.7	**143.2**
Kopaonik (1950-2021)	14	10	224.1	279.6	323.8	**201.0**
Kursumlija (1952-2021)	23	10	129.2	175.7	208.0	**113.3**
Krusevac (1927-2021)	47	22	137.0	172.5	209.9	**178.5**
Cuprija (1948-2021)	45	22	143.8	185.8	204.9	**200.4**
Nis (1925-2021)	23	11	125.9	150.2	178.7	**109.5**
Leskovac (1948-2021)	16	9	126.2	150.3	179.6	**101.2**
Zajecar (1929-2021)	14	6	115.7	156.2	172.8	**88.4**
Dimitrovgrad (1945-2021)	50	25	150.2	175.7	203.5	**185.3**
Vranje (1926-2021)	40	18	112.0	144.3	179.9	**120.6**

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

**Rank – 1981-2021 period (lowest seasonal precipitation)

Country	Seasonal temperature JJA		Seasonal precipitation JJA		High Impact Events
	Observed	SEECOF-25 climate outlook for temperature	Observed	SEECOF-25 climate outlook for precipitation	
Serbia (1)	Above normal in entire Serbia	**Above-normal** (20, 30, 50) in entire Serbia	Normal and below normal in most of Serbia	**No predictive signal** (33, 34, 33) in entire Serbia	❖ Fifth warmest summer for Serbia since 1951, and 3rd warmest for Belgrade since 1888 and at Kopaonik since 1950 ❖ 4th warmest for Valjevo since 1926 and at Zlatibor since 1950 ❖ Up to 22 summer days, 28 tropical days and 28 tropical nights more than normal ❖ 4th driest summer at Zlatibor since 1950

Analysis of the summer season 2021 for Serbia relative to the 1981-2010 base period

Temperature

Summer 2021 ranks as the 5th warmest summer for Serbia in the period from 1951 to 2021 (Figure 1) while the warmest was 2012, 3rd warmest for Belgrade since 1888 (Figure 2) and Kopaonik since 1950 (Figure 3) and 4th warmest for Valjevo since 1926 and Zlatibor since 1950. 15 out of 20 warmest summer seasons was recorded since 2000.

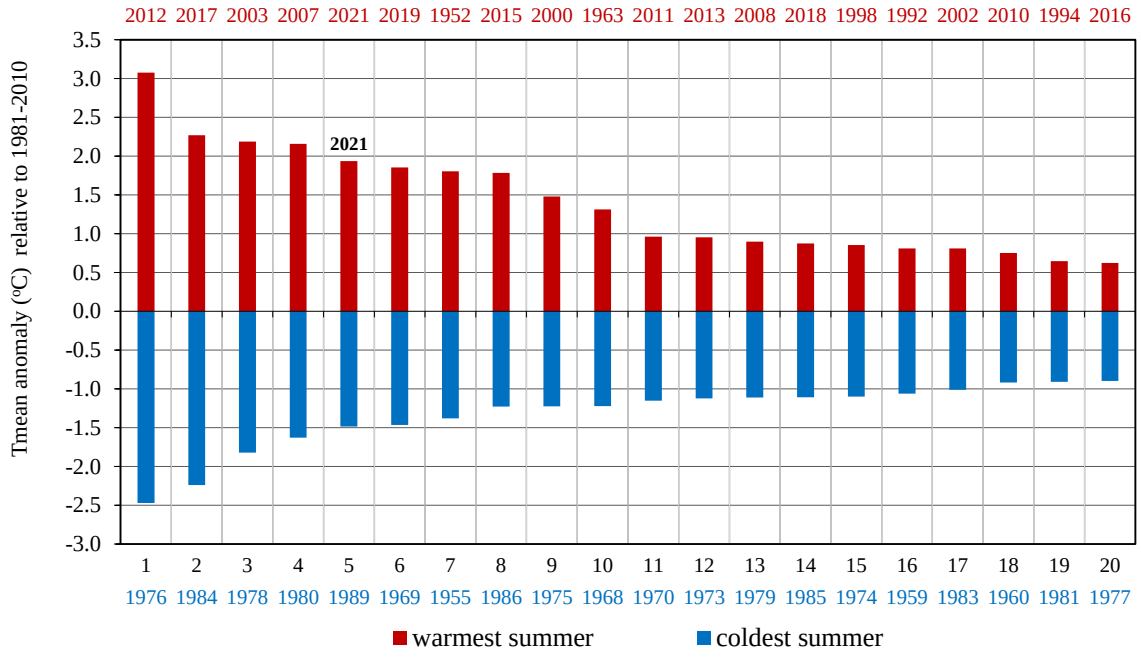


Figure 1. Rank of twenty warmest and coldest summers in Serbia for the 1951-2021 period

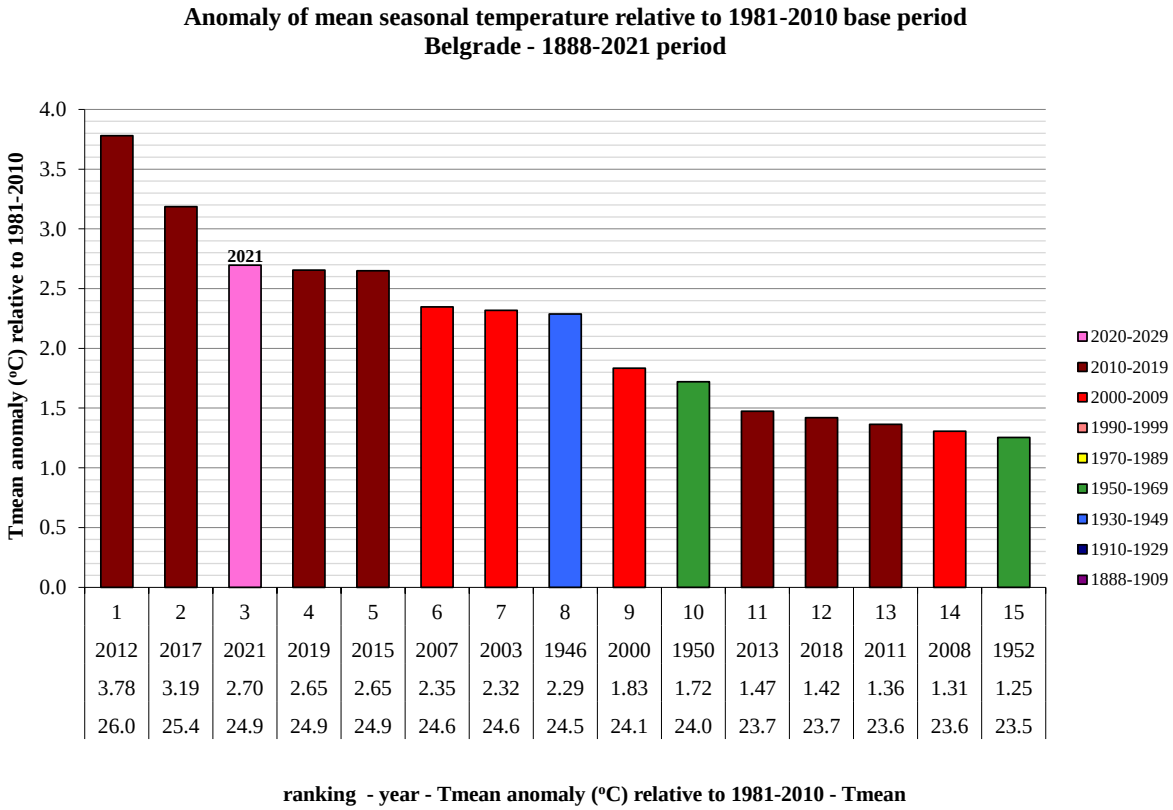


Figure 2. Rank of the warmest summers in Belgrade

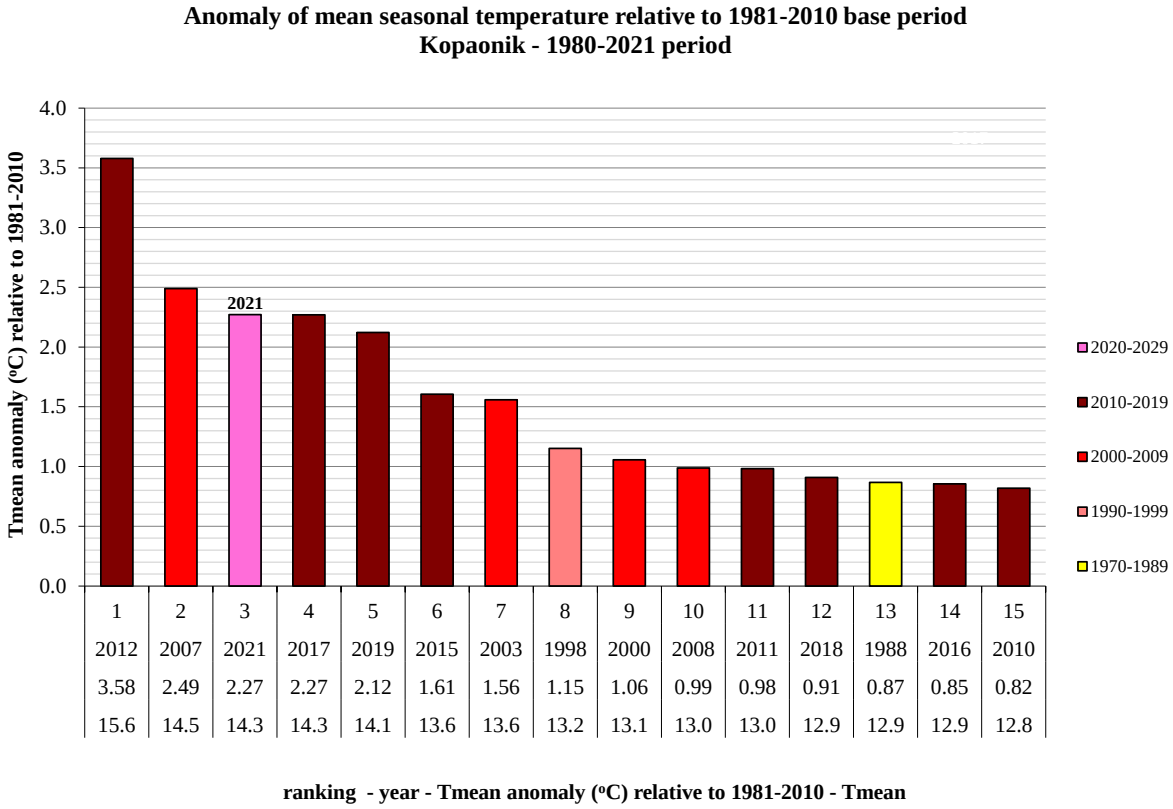


Figure 3. Rank of the warmest summers at Kopaonik

Mean summer air temperature ranged from 20.6ºC in Pozega to 24.9ºC in Belgrade, and on the mountains from 14.3ºC at Kopaonik to 19.3ºC at Zlatibor (*Figure 4*).

Departure of the summer mean air temperature from the normal[1] ranged from +1.0ºC in Zajecar to +2.7ºC in Belgrade and in the upland from +1.8ºC in Sjenica to +2.5ºC at Zlatibor (*Figure 5).*

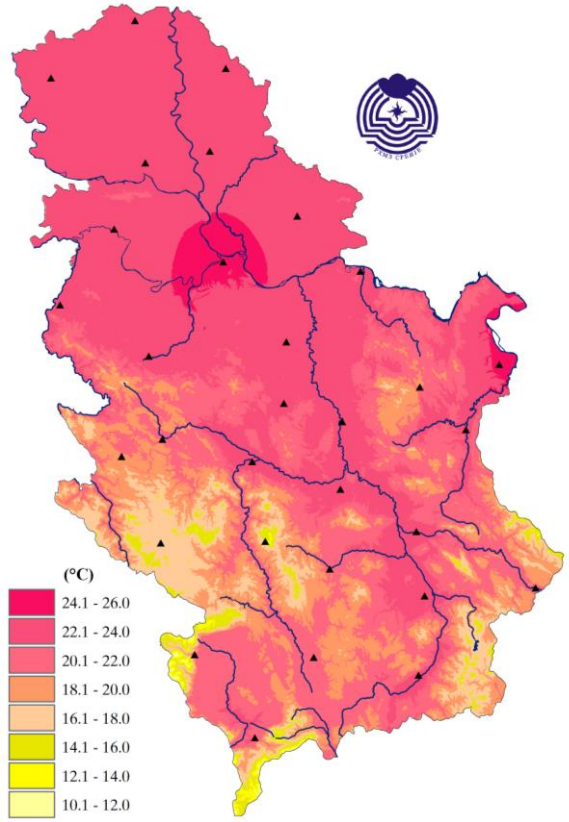


Figure 4. Spatial distribution of mean summer air temperature

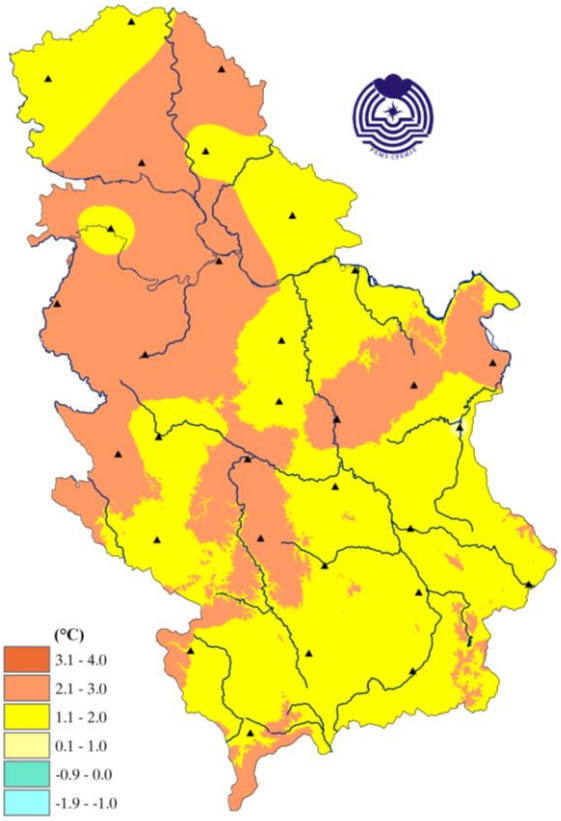


Figure 5. Spatial distribution of mean summer air temperature anomaly from the normal

[1] Term ***normal*** refers to ***climatological standard normal***, that is, the average value of a particular climatological element, calculated for the period from January 1, 1981 to December 31, 2010

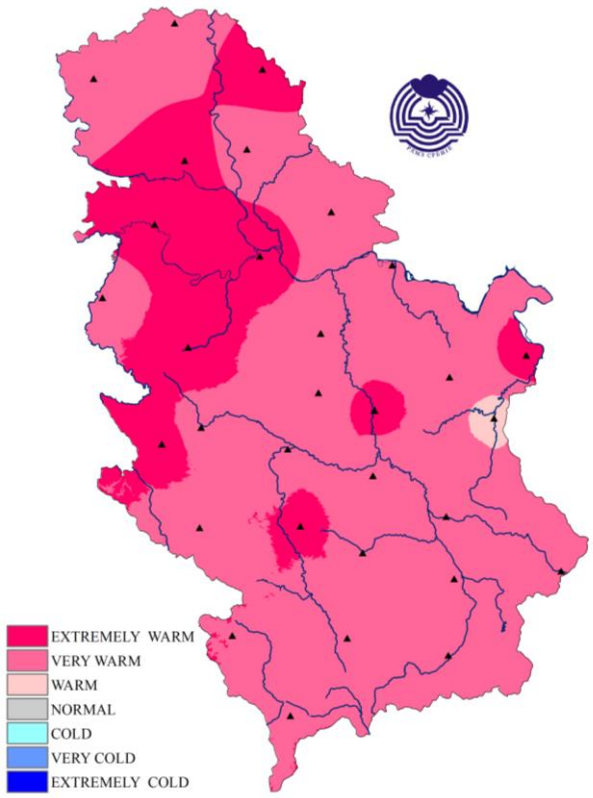


Figure 6. Spatial distribution of mean summer air temperature according to the percentile method

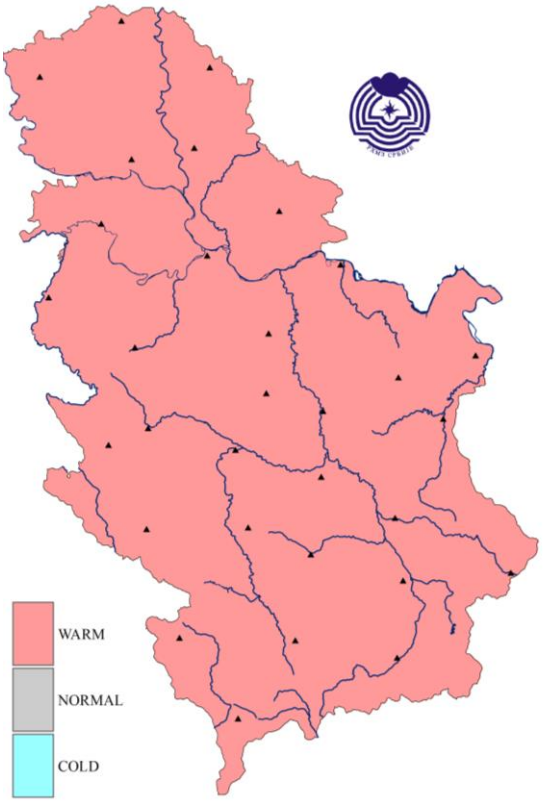


Figure 7. Spatial distribution of mean summer air temperature according to the tercile method

Based on the percentile method[2], mean summer air temperature was in the following categories: very warm in most of Serbia, extremely warm in parts of northern, western, eastern and central parts, and warm category in Zajecar (*Figure 6*).

Based on the tercile method, mean summer air temperature was in the warm category across entire Serbia (*Figure 7).*

The highest daily air temperature in summer 2021 was 40.7ºC measured in Smederevska Palanka on June 30.

The lowest summer air temperature of 0.4ºC was measured in Sjenica on June 3. On the same day, lowest summer air temperature of 4.1ºC was measured in Dimitrovgrad.

[2] **n**- th 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

Number of summer days[3] ranged from 71 days in Pozega to 86 in Negotin and Zajecar, and on the mountains from 9 at Kopaonik to 50 Zlatibor and Sjenica. Depature of the number of summer days was above the average in entire Serbia (Figure 8), ranging from 7 at Kopaonik to 22 days at Zlatibor. Belgrade recorded 78 summer days, which is 10 days above the average.

Number of tropical days[4] ranged from 45 days in Pozega and Kragujevac to 61 days in Veliko Gradiste, and on the mountains from zero at Kopaonik to 26 days at Zlatibor. The recorded number of tropical days was above the average in entire Serbia apart from Kopaonik, ranging from 5 days at Crni Vrh to 28 days above the average in Veliko Gradiste (*Figure 9*).

Belgrade observed 44 tropical nights[5], which is 28 days above the average, and in the upland to 10 days at Crni Vrh, which is 8 days above the summer average. Most of Serbia recorded positive deviation of the number of tropical night, whereas Kursumlija, Pozega, Zajecar, Dimitrovgrad and Kopaonik didn't record any.

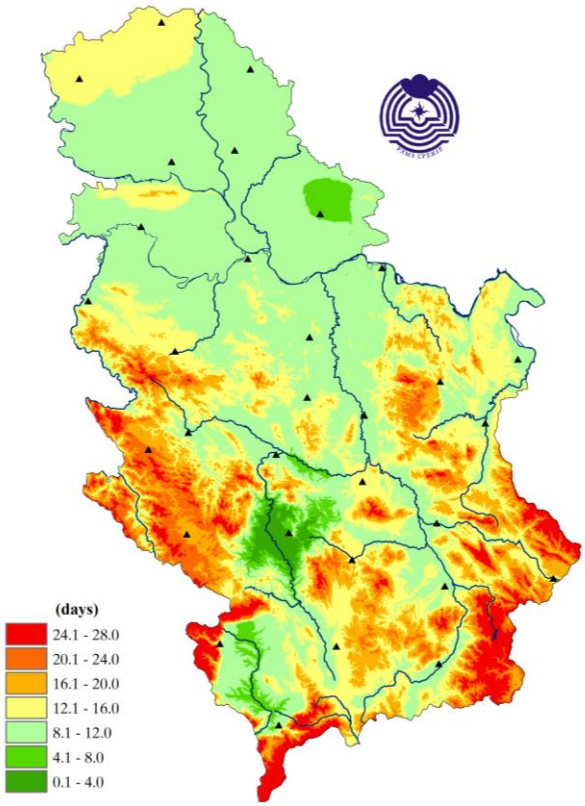


Figure 8. Deviation of the number of summer days from the normal

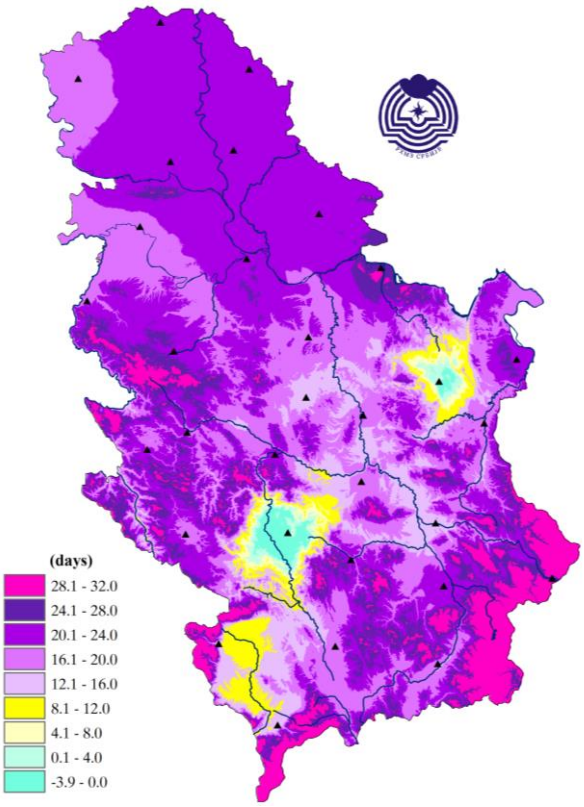


Figure 9. Deviation of the number of tropical days from the normal

[3] Summer day is defined as the day with the maximum daily air temperature of 25°C and above
[4] Tropical day is defined as the day with the maximum daily air temperature of 30°C and above
[5] Tropical night is defined as the day with the minimum daily air temperature of 20°C and above

Mean, maximum and minimum air temperature were within the multiannual average in Belgrade during first half of June, at the beginning of first and second week of July above the average, in the third decade of June, first half and end of July, at the beginning and middle of August above the average, and in the middle of June and at the end of August below the average (*Figure 10).*

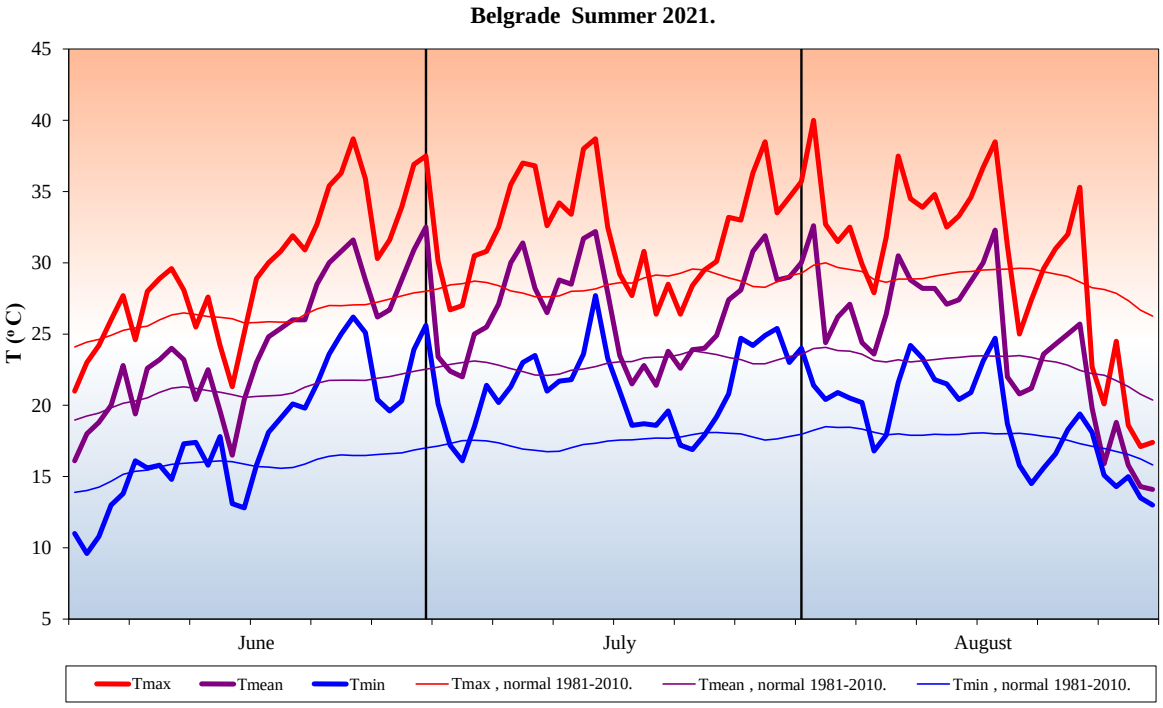


Figure 10. Three – month course of mean, maximum and minimum daily air temperature in Belgrade

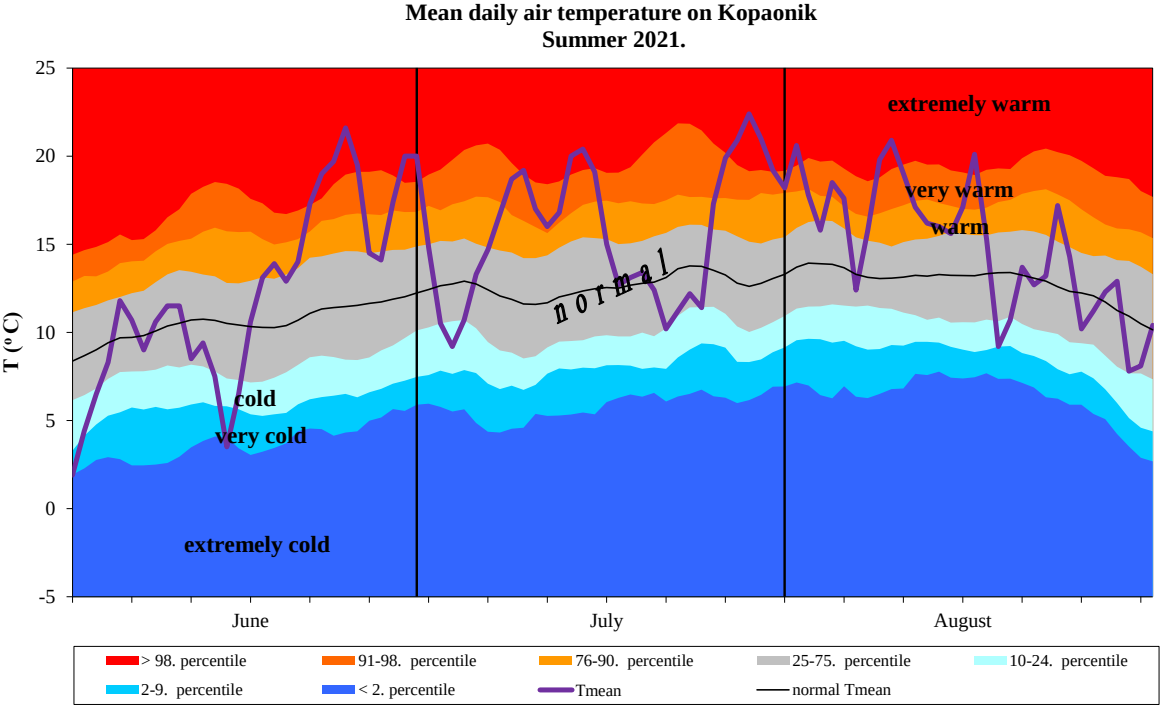


Figure 11. Three – month course of mean daily air temperature at Kopaonik

Figures 12 and 13 show assessment of the mean, maximum and minimum air temperature and precipitation sums for Serbia for the summer based on the tercile distribution relative to the 1981-2010 base period. It can be noted that summer 2021 was marked by mean, minimum and maximum air temperature was significantly above the average and precipitation sums at the lower boundary of the average values.

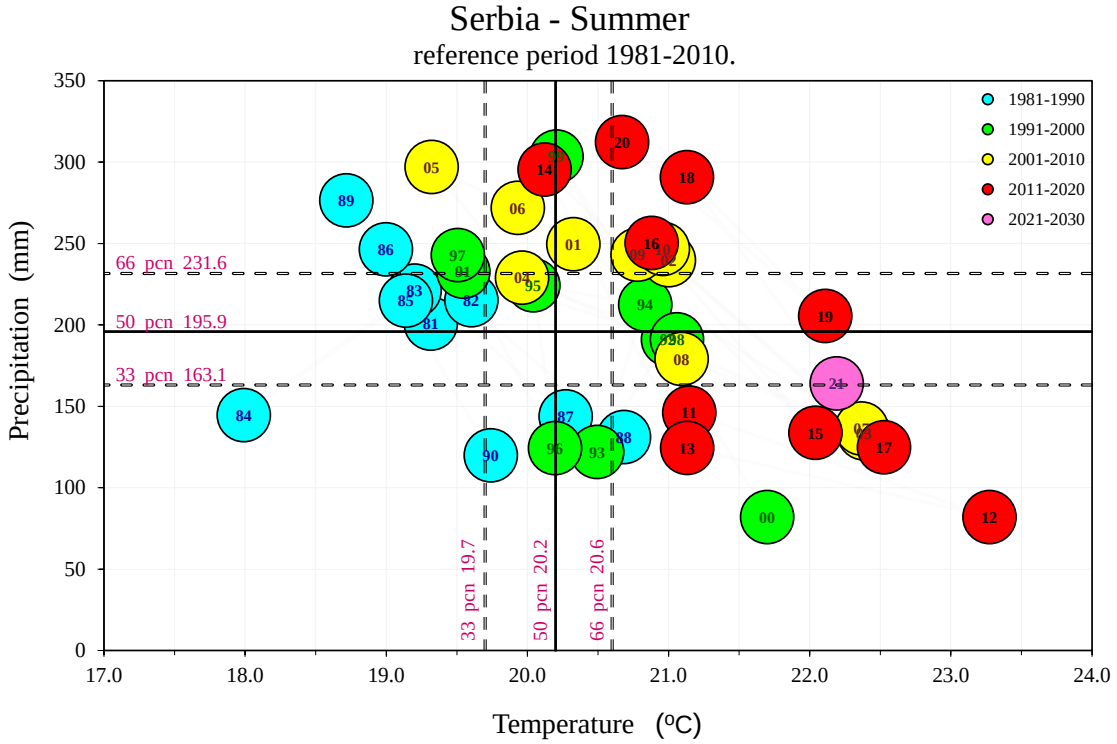


Figure 12. Assessment of precipitation sums and mean air temperature for summer in Serbia based on the accompanying terciles relative to the 1981-2010 base period

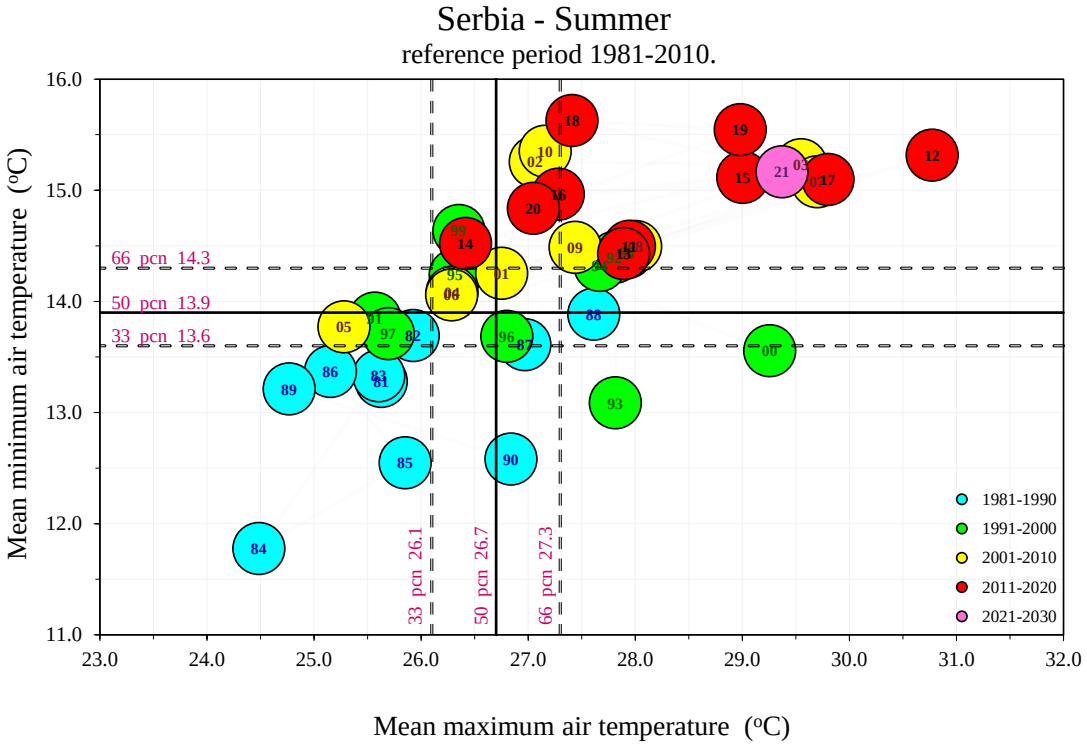


Figure 13. Assessment of maximum and minimum air temperature for summer in Serbia based on the accompanying terciles relative to the 1981-2010 base period

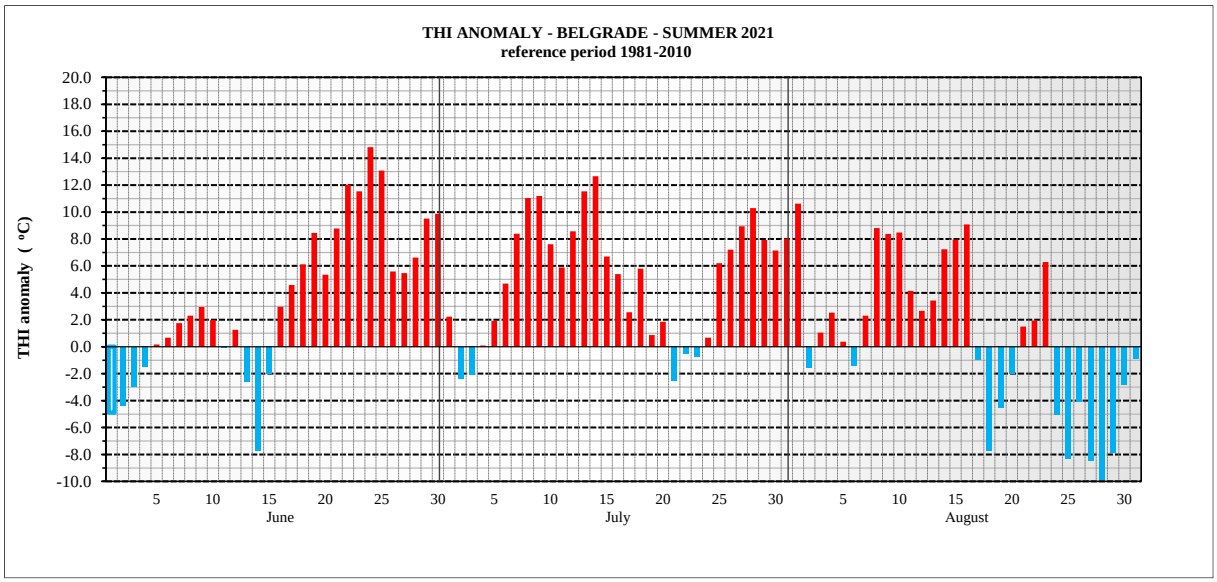


Figure 14.

Departure of the Heat Stress Index (THI)[6] was positive most of the summer seasons, apart from beginning and middle of June and second part of August when it was negative (Figure 14). The highest discrepancy between feels like temperature and the maximum daily air temperature was 7.2°C measured on July 16 (Figure 15). On that day, the maximum air temperature of 29.2°C whereas feels like temperature was 36.4°C. The maximum THI for summer was 44.6°C measured on June 24, 2021. There were 19 days with THI above 40°C, and 68 days with temperature above 30°C.

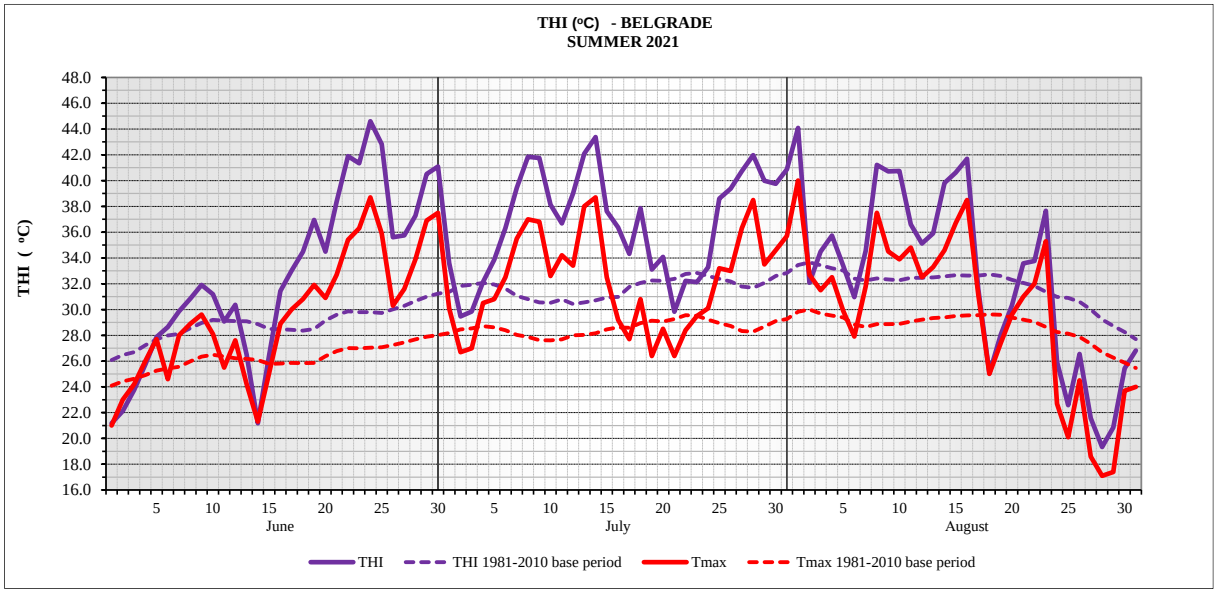


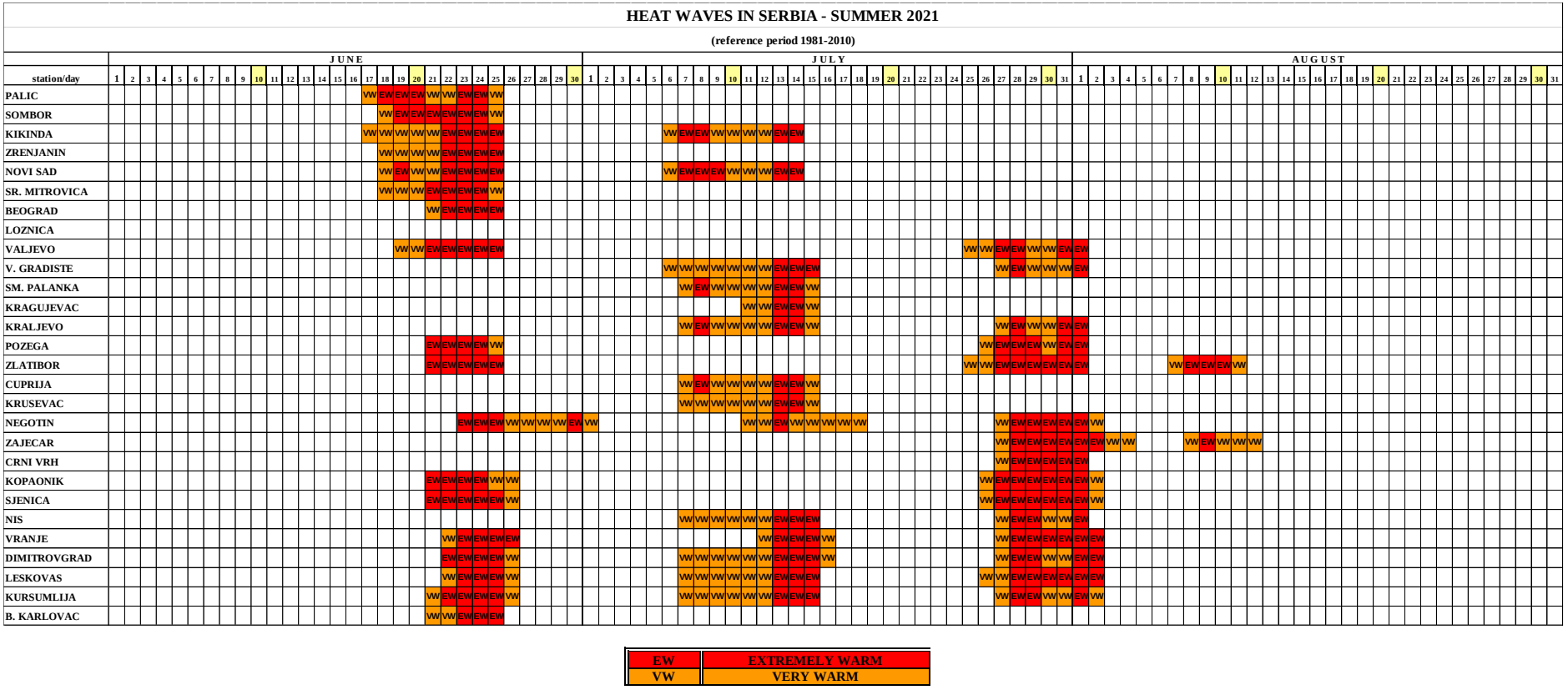
Figure 15.

[6] 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 2021

There were 4 heat waves[7] (Chart 1) in the summer 2021 across Serbia. The onset of the first heat wave was registered in the north, lasting from June 17 to 25, elsewhere from June 21 to 26, and in Negotin from June 23 to August 25. Second heat wave was observed in most of Serbia from July 6 to 16, in Negotin to 18 july. The third heat wave was observed in the period from July 25 to August 2, and the fourth heat wave in Zajecar lasted until August 4. The fourth heat wave was recorded only at Zlatibor and Zajecar, lasting from August 7 to 12.

Chart 1.



[7] Heat wave, according to the percentile method, is a period during which maximum daily air temperature is in the very warm and extremely warm categories for five days or longer

Precipitation

Summer precipitation totals in Serbia ranged from 79.6 mm in Negotin to 263.1 mm in Sombor (*Figure*). Precipitation sums relative to the normal ranged from 45% at Zlatibor to 131% in Sombor (*Figure 17*).

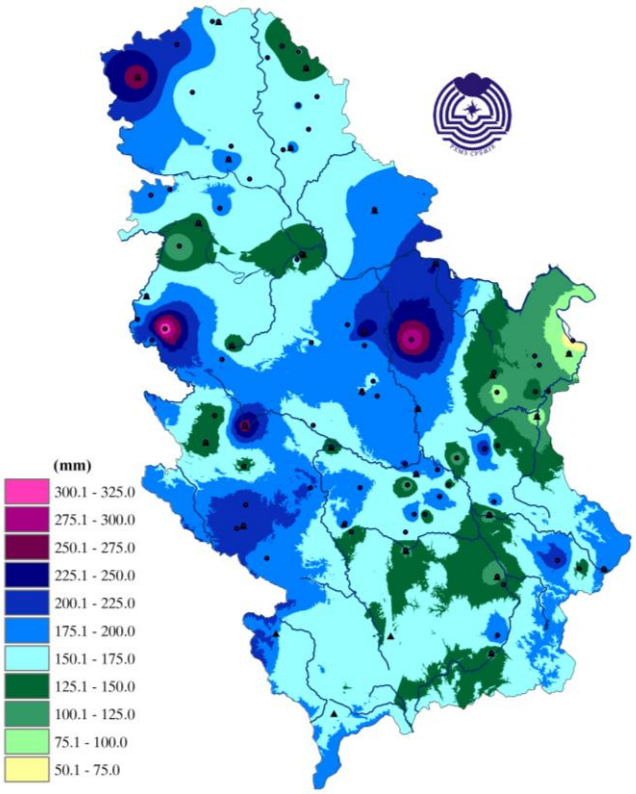


Figure 16. Spatial distribution of summer precipitation sums based on data from 28 principal, 16 climatological and 44 rain gauge stations

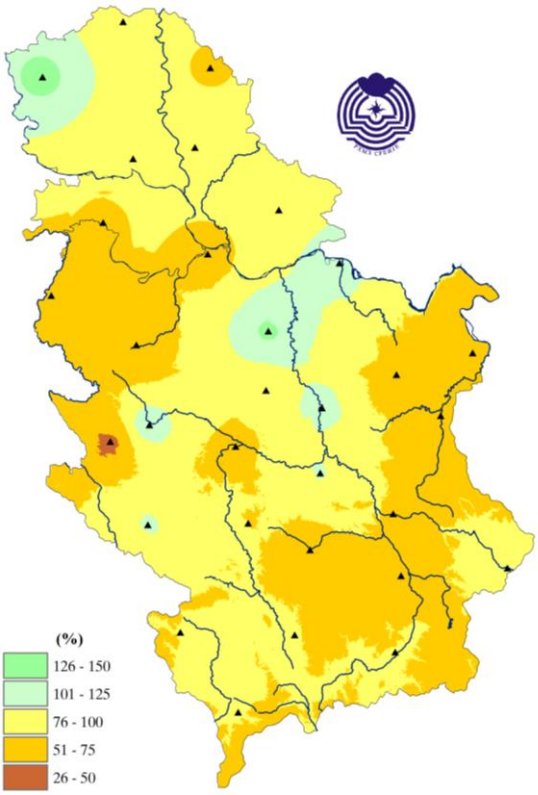


Figure 17. Spatial distribution of summer precipitation sums in percentage of normal

Based on the percentile method, summer precipitation sums were in the normal and dry categories in most of Serbia, rainy category in Sombor and Smederevska Palanka, very rainy in Valjevo and Loznica, extremely dry at Zlatibor (*Figure 18*).

Based on the tercile method, precipitation sums were in the upper tercile in Sombor, Smederevska Palanka and Pozega, in the lower tercile in eastern, northeastern and some parts of western and central Serbia, elsewhere within the average (*Figure 19*).

The maximum daily precipitation sum of 96.2 mm was recorded in Dimitrovgrad on July 16.

Summer 2021 ranks as **the 4th driest** for Zlatibor (*Figure 20*) since 1950.

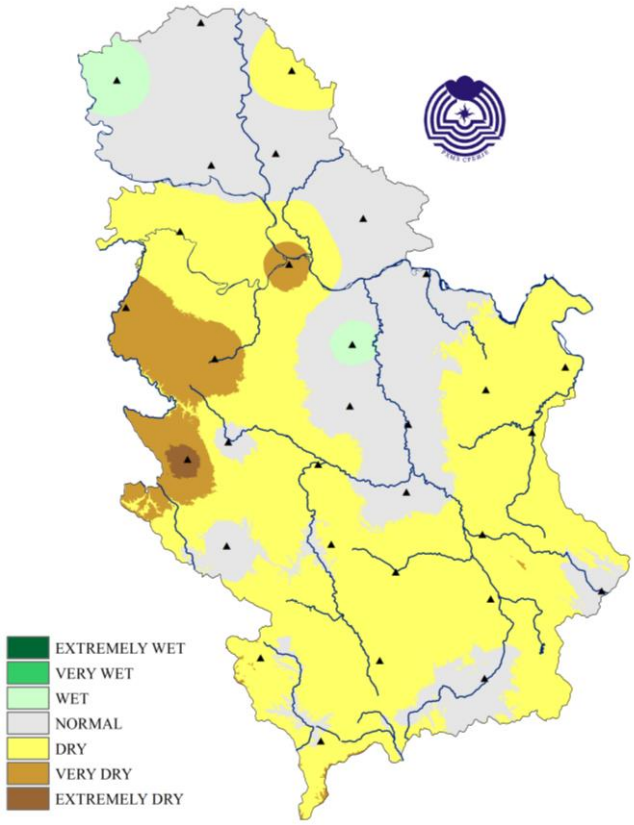


Figure 18. Summer precipitation sums according to the percentile method

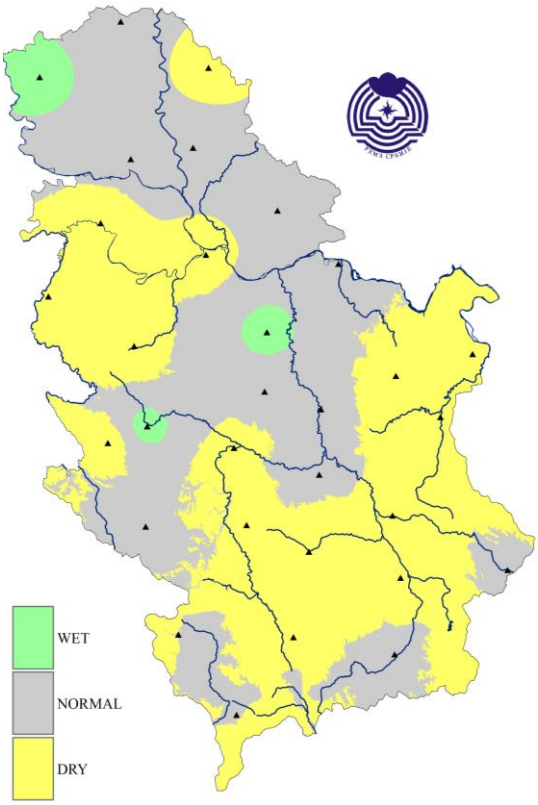


Figure 19. Summer precipitation sums according to the tercile method

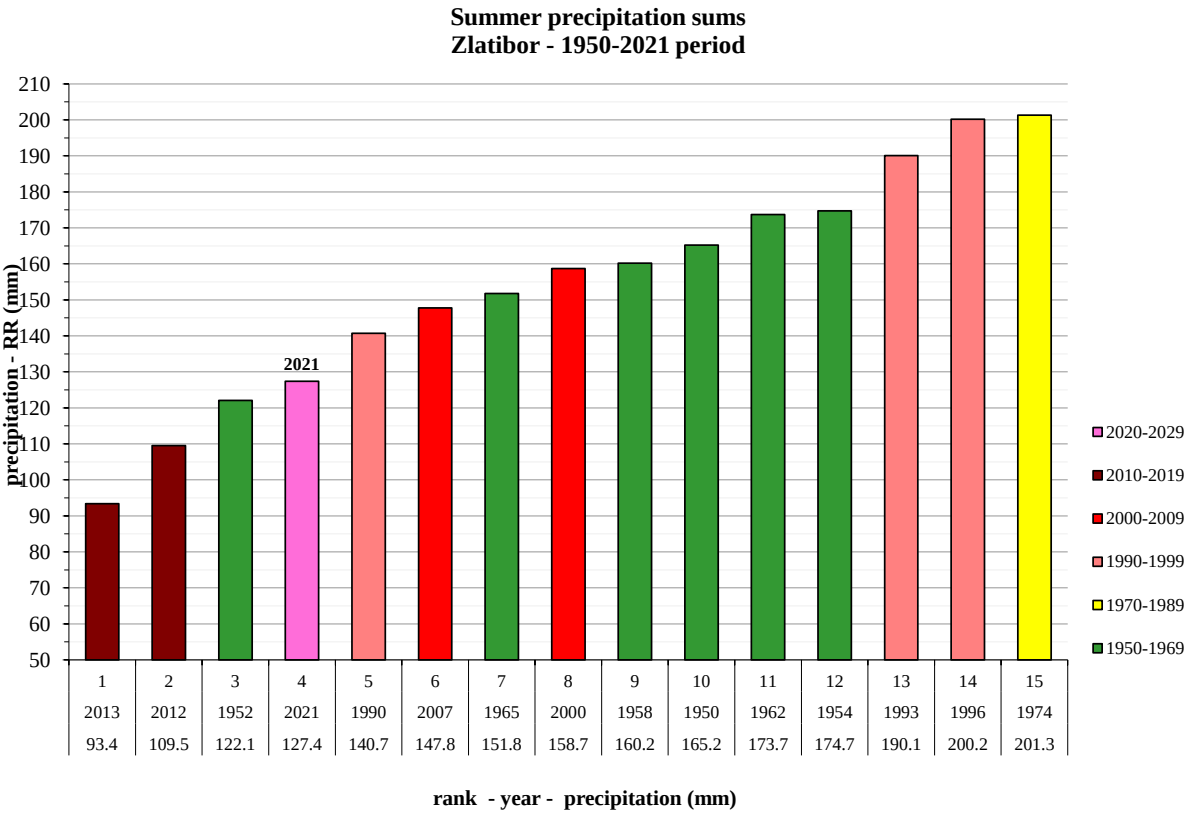


Figure 20. Rank of the driest summers at Zlatibor

Number of days with precipitation recorded in the summer ranged from 15 days in Negotin to 33 days at Kopaonik. The recorded number of days with precipitation was below the average in entire Serbia, up to 10 days below the average in Belgrade with 22 rainy days during summer (*Figure 21*).

In summer, entire country apart from Loznica and Negotin, recorded days with daily precipitation sums above 20 mm, up to 4 days in Sombor, Smederevska Palanka and Sjenica, which is 2 days above the summer average (*Figure 22*).

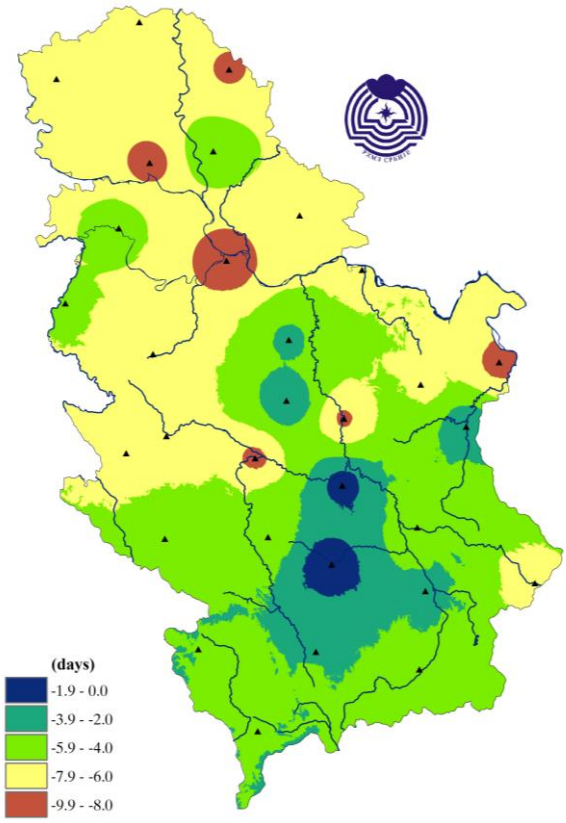


Figure 21. Deviation of number of days with precipitation of 0.1 mm and more from the normal

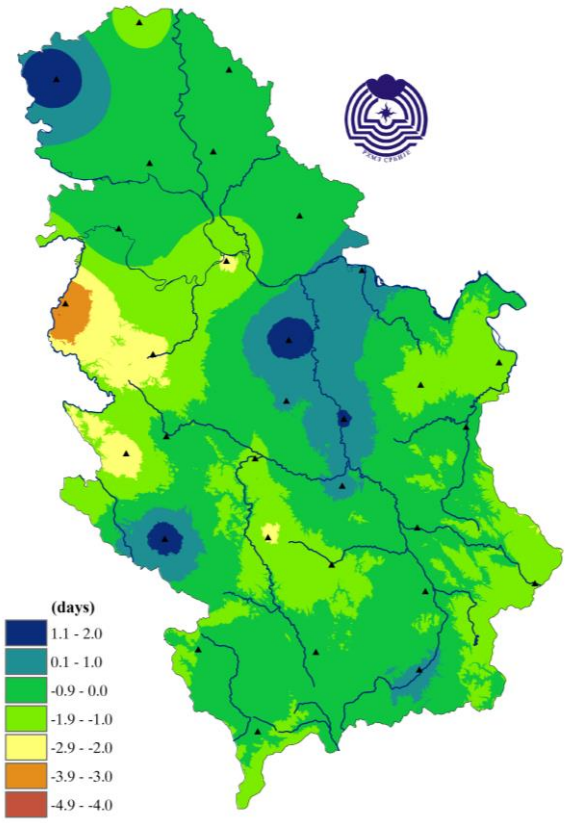


Figure 22. Deviation of number of days with precipitation of 20 mm and more from the normal

In summer, number of thunder days ranged from 6 in Kikinda (16 days below the average) to 29 days in Sjenica (5 days above the average). Most of Serbia recorded fewer thunder days than average apart from certain parts of western, central and eastern Serbia where 2 to 5 days above the summer average was observed (*Figure 23*). **Kikinda observed record low number of thunder days during summer** ever since the record-keeping began. The previous record, total of 10 thunder days was registered in summer 1981.

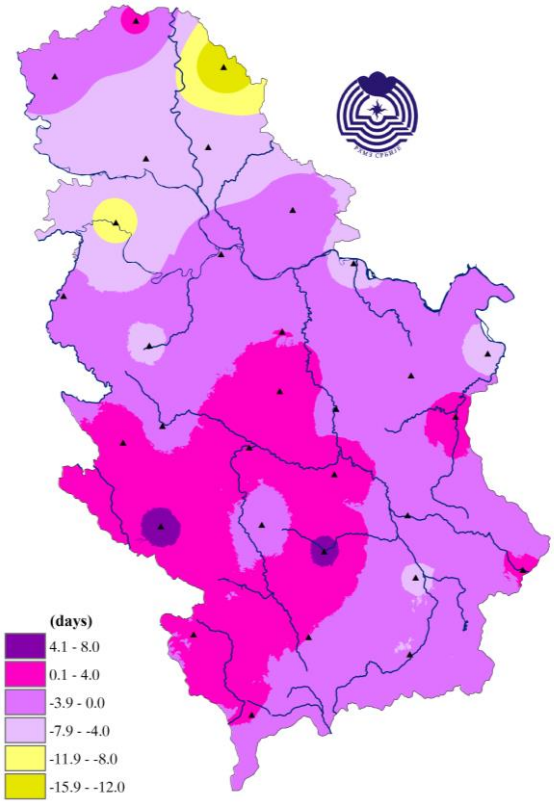


Figure 23. Deviation of number of days with thunder from the normal

Figures 24 and 25 show cumulative precipitation sums in summer for Sombor and Zlatibor per months relative to the average cumulative precipitation sums.

Cumulative precipitation sums in Sombor

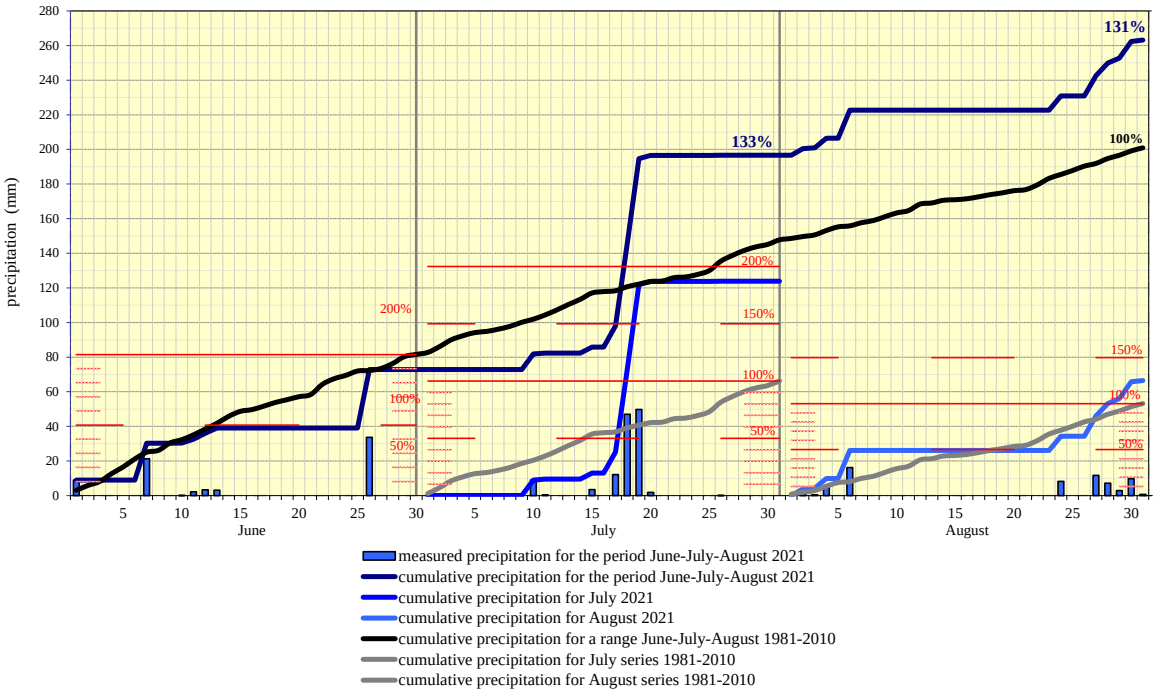


Figure 24. Cumulative precipitation sums for Sombor

Cumulative precipitation sums in Zlatibor

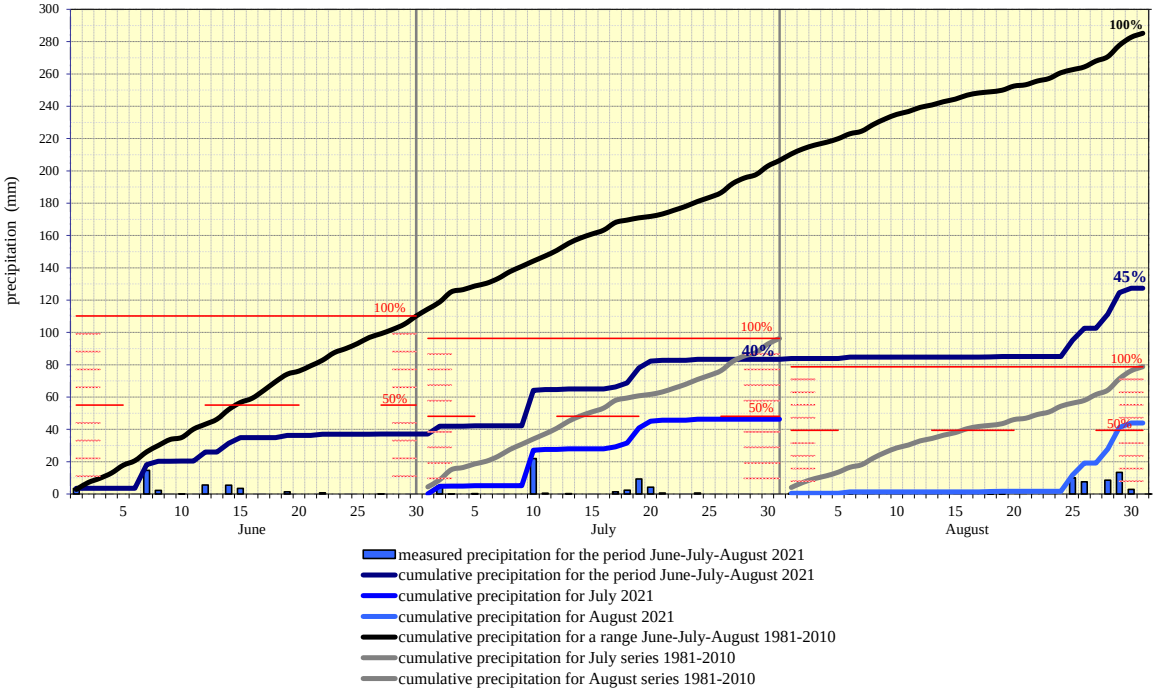


Figure 25. Cumulative precipitation sums for Zlatibor

Cloud cover, bright and cloudy days

Mean summer cloud cover was below the average in most of Serbia, ranging from 3/10 in Negotin (*Figure 26*) to 5/10 at Kopaonik (*Figure 27*).

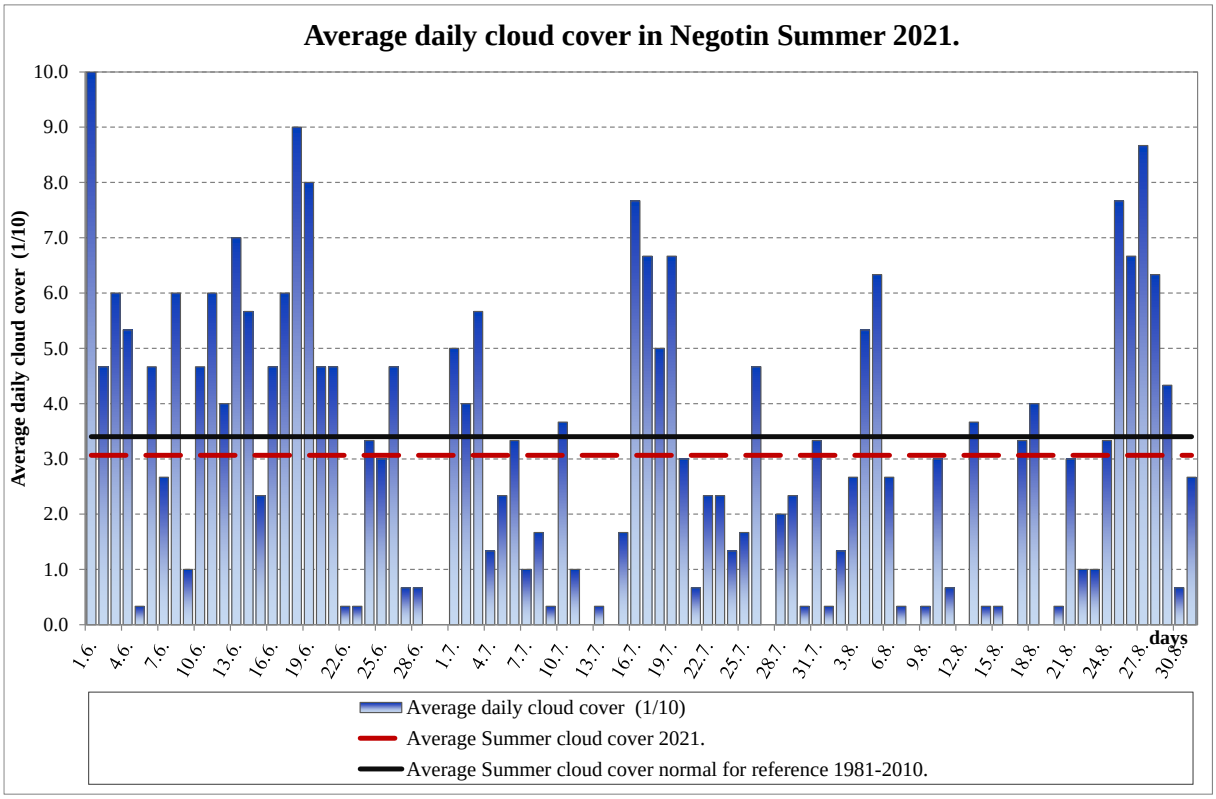


Figure 26. Average daily cloud cover in Negotin

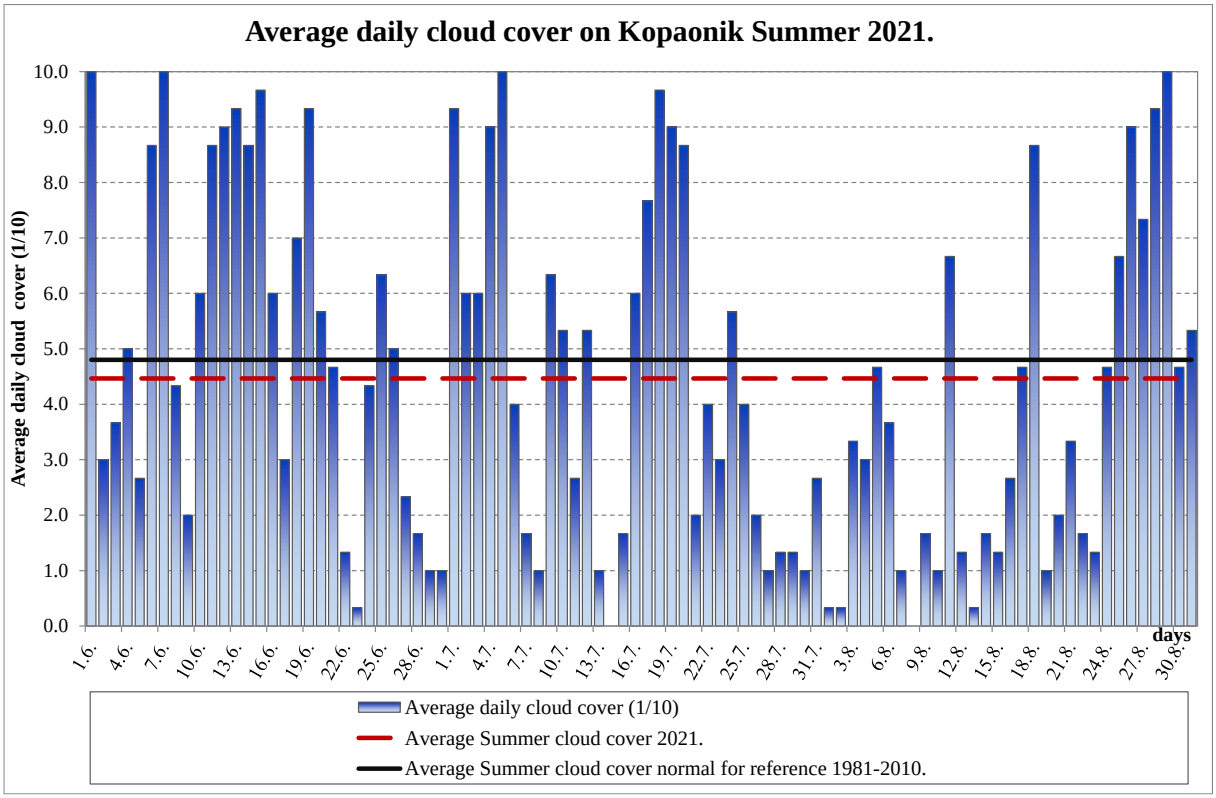


Figure 27. Average daily cloud cover at Kopaonik

In summer, number of bright days[8] ranged from 25 days in Sremska Mitrovica, (4 days below the average) to 44 bright days in Nis (13 days above the average). Number of cloudy days[9] ranged from 3 days in Negotin to 19 days at Kopaonik, which is 10 days above the average. Number of cloudy days was below the average across the entire country, up to 11 days below the average at Crni Vrh with the exception of Kopaonik with 2 cloudy days above the average.

Sunshine duration (insolation)

In summer, insolation ranged from 773 hours in Sjenica to 984 hours in Negotin (*Figure 28*).

Relative to the normal for the 1981-2010 base period, insolation ranged from 96% in Zajecar to 127% in Pozega (*Figure 29*).

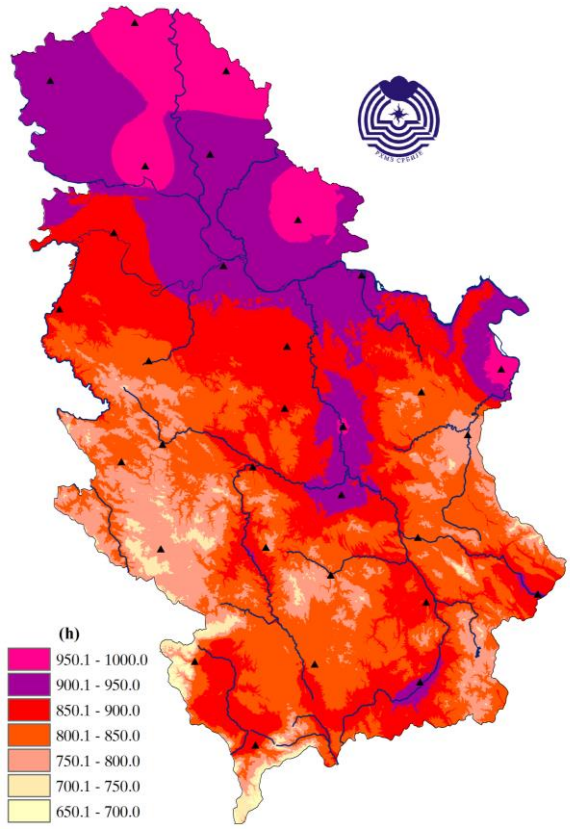


Figure 28. Insolation in hours

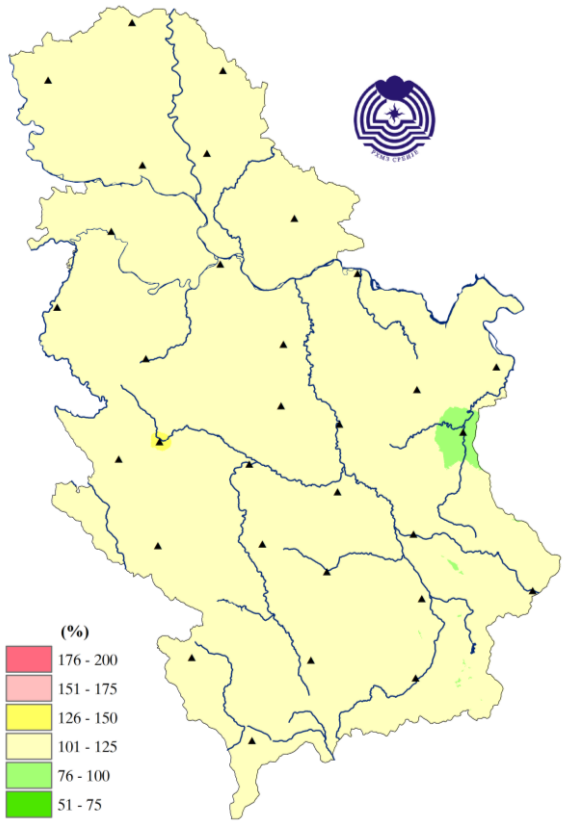


Figure 29. Insolation in percentage of normal

[8] Bright day is a day with average daily cloud cover of less than 2/10
[9] Cloudy day is a day with average daily cloud cover of more than 8/10

Analysis of the summer season 2021 for Serbia relative to the 1961-1990 base period

Temperature

In summer, departure of the mean air temperature from the normal for the 1961-1990 base period ranged from 2.9ºC in Pozega to +3.9ºC in Belgrade, and on the mountains from +2.9ºC in Sjenica to +3.6ºC at Kopaonik and Zlatibor (*Figure 30*).

Based on the percentile method, mean summer air temperature was in the category of warm and very warm across the entire country (*Figure 31*).

Based on the tercile method, mean summer air temperature was in the warm category in the entire country.

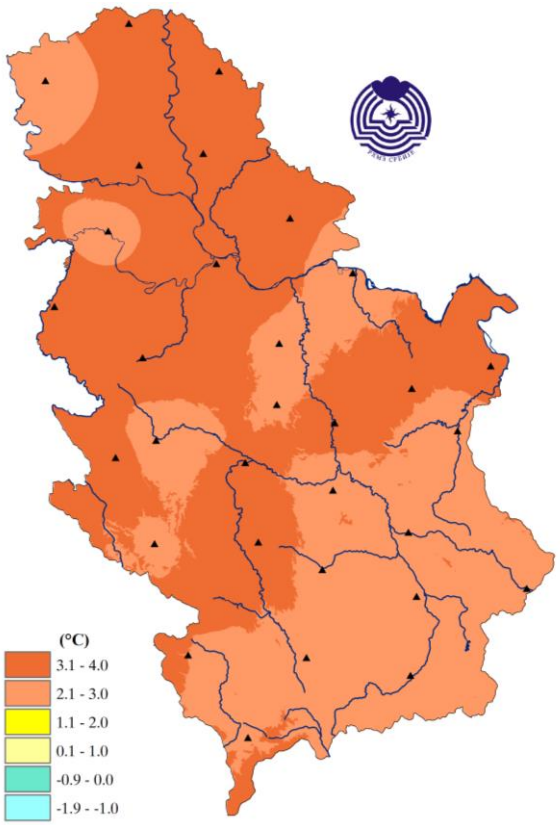


Figure 30. Spatial distribution of mean summer air temperature anomaly from the 1961-1990 normal

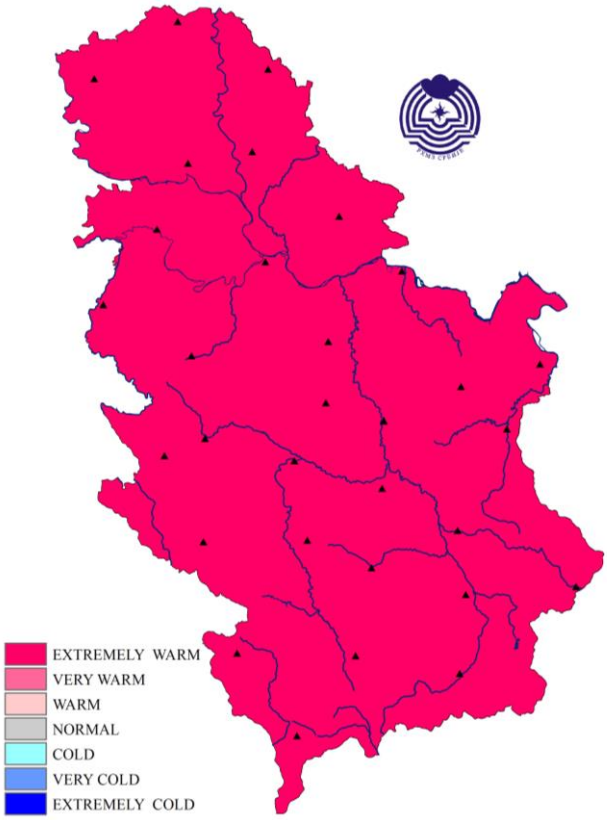


Figure 31. Spatial distribution of mean summer air temperature according to the percentile method

Precipitation

Summer precipitation sums compared to the normal for the 1961-1990 base period ranged from 45% at Zlatibor to 137% in Sombor (*Figure 32*).

Based on the percentile method, summer precipitation sums were in the following categories: normal and dry in most of Serbia, very rainy in the northwest, rainy in Smederevska Palanka, very dry in Zajecar and Kraljevo, and extremely dry in parts of western Serbia (*Figure 33*).

Based on the tercile method, precipitation sums in Sombor, Smederevska Palanka and Pozega were in the upper tercile, in the eastern, western and parts of central Serbia in the lower tercile, and within the average elsewhere.

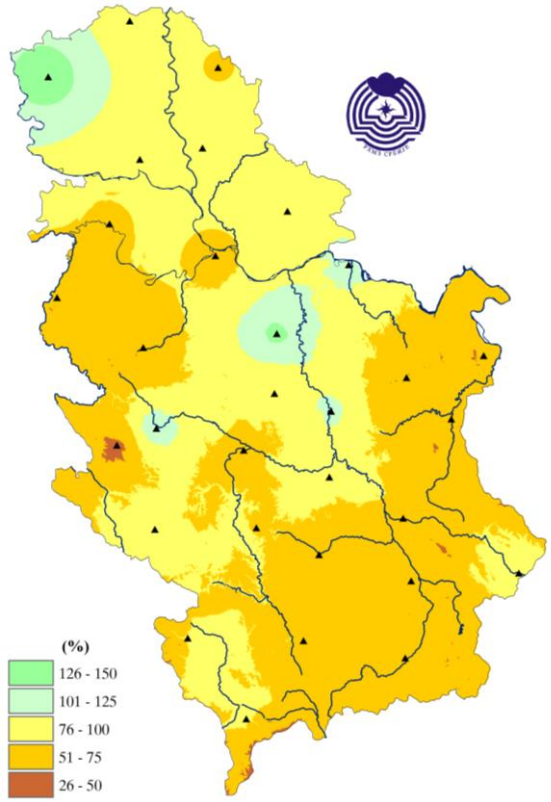


Figure 32. Spatial distribution of spring precipitation sums in percentage of the 1961-1990 normal

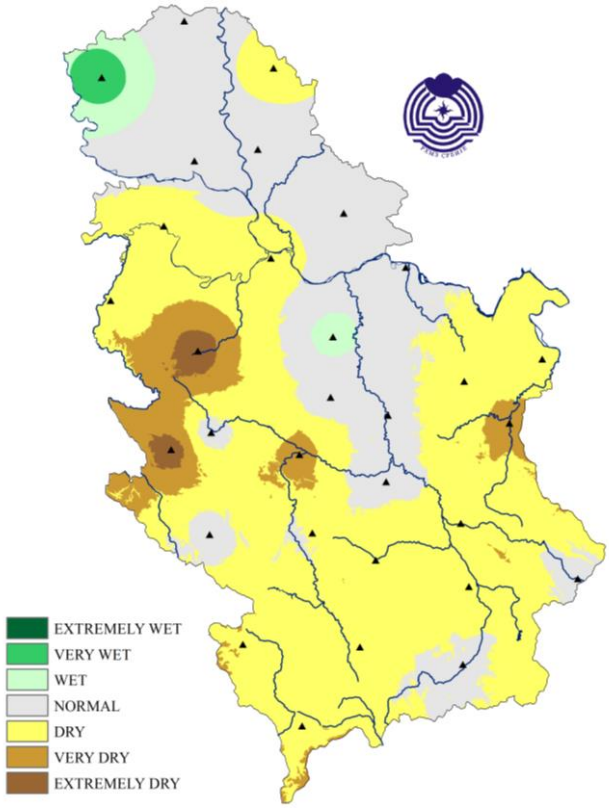


Figure 33. Summer precipitation sums according to the percentile method

Note: Climatological analysis of the meteorological elements based on the preliminary data obtained from the 28 principal meteorological stations