



VERIFICATION OF THE SEECOF-27 SUMMER 2022 CLIMATE OUTLOOK AND SEASONAL BULLETIN FOR THE TERRITORY OF SERBIA

Belgrade, 17 October 2022

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Temperature

The SEECOF-27 outlook for the summer 2022 in Serbia indicated warmer than normal temperature in Serbia with 70% probability relative to the 1981–2010 climatological base period (Figure A).

Climatological monitoring showed that the summer 2022 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 2022

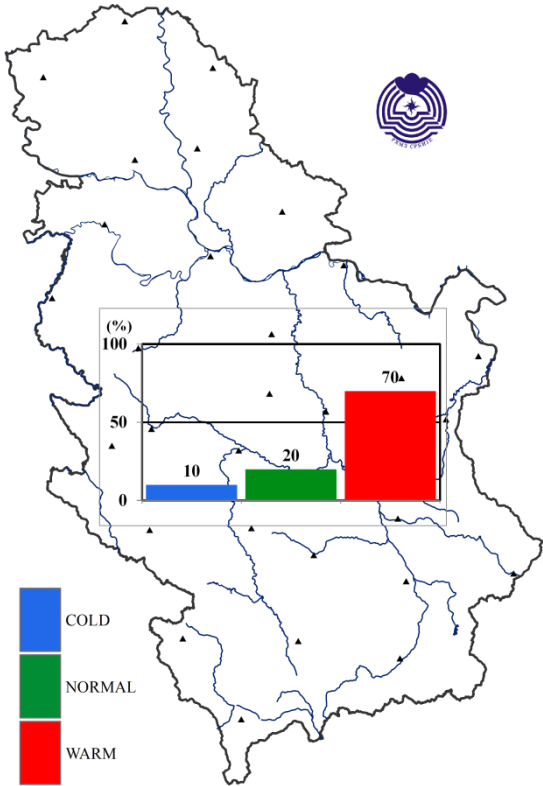


Figure A. SEECOF-27 - summer temperature outlook

MONITORING – SUMMER 2022

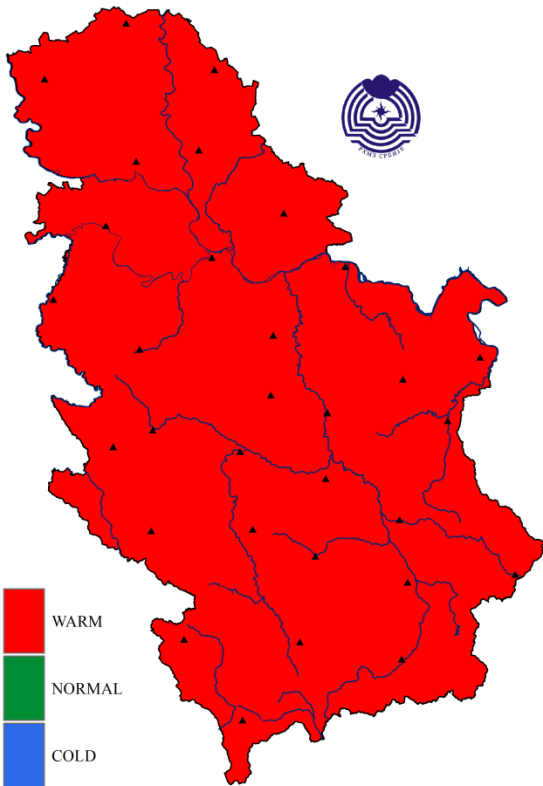


Figure B. Monitoring of the summer temperature using tercile method compared to the 1981-2010 base period

Precipitation

According to the SEECOF-27 outlook for the summer 2022 indicated drier than normal conditions for Serbia with 50% probability relative to the 1981–2010 climatological base period (Figure C).

Based on the climatological monitoring of precipitation, the summer of 2022 was below normal in northern and part of western Serbia. Above average precipitation were in central, southeastern and part of western Serbia (Figure D). The outlook for a dry summer was correct for northern and part of western Serbia.

OUTLOOK – SUMMER 2022

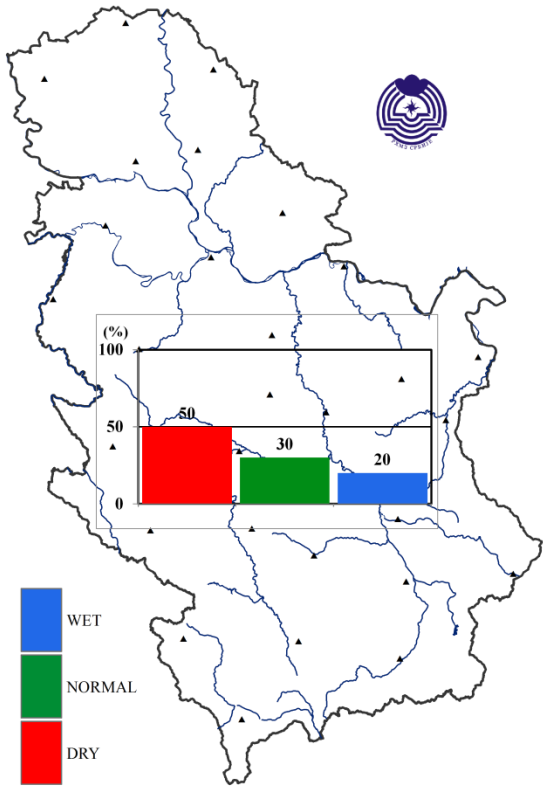


Figure C. SEECOF-27 - summer precipitation outlook

MONITORING – SUMMER 2022

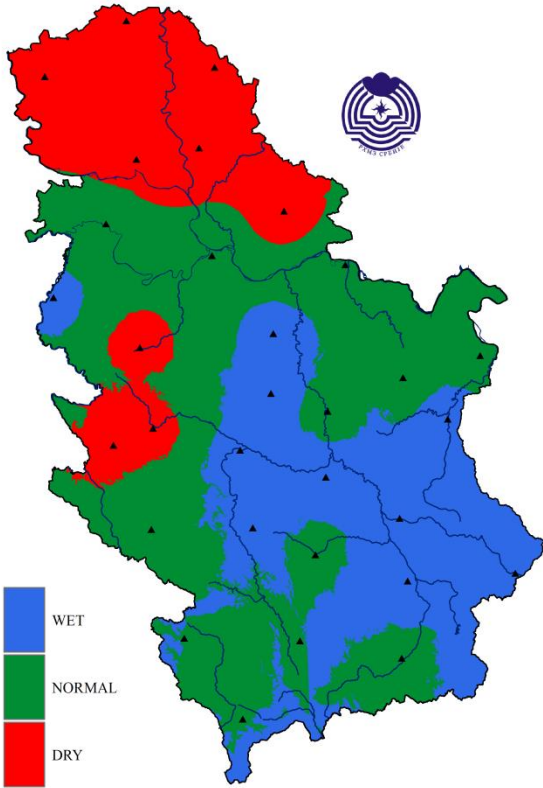


Figure D. Monitoring of the summer precipitation using tercile method compared to the 1981-2010 base period

Summer 2022		Air Temperature (°C)				
Station	Rank*	Rank**	33	50	66	Observed value
Beograd (1888-2022)	3	3	21.6	22.0	22.9	25.2
Palić (1945-2022)	1	1	20.9	21.3	21.9	24.3
Sombor (1942-2022)	3	3	20.6	21.0	21.3	23.9
Novi Sad (1948-2021)	1	1	20.8	21.0	21.6	24.5
Zrenjanin (1946-2022)	1	2	21.0	21.2	21.7	24.7
Kikinda (1948-2022)	1	1	20.8	21.3	21.7	24.3
Banatski Karlovac (1986-2021)	1	1	20.9	21.3	21.8	23.9
Loznica (1952-2022)	4	4	20.7	21.0	21.7	23.4
Sremska Mitrovica (1925-2022)	2	4	20.5	20.8	21.2	23.1
Valjevo (1926-2022)	3	4	20.5	20.9	21.6	23.7
Kragujevac (1925-2022)	5	9	20.6	21.2	21.6	23.1
Smederevska Palanka (1939-2022)	8	11	20.8	21.3	21.8	23.1
Veliko Gradište (1926-2022)	1	2	20.4	21.1	21.4	23.6
Crni Vrh (1967-2022)	3	3	15.9	16.3	16.6	18.7
Negotin (1927-2022)	2	6	22.0	22.7	23.1	<u>25.1</u>
Zlatibor (1950-2022)	7	7	16.3	16.8	17.3	18.9
Sjenica (1946-2022)	5	5	15.3	15.9	16.2	17.5
Pozega (1952-2022)	2	2	18.9	19.4	19.5	21.1
Kraljevo (1926-2022)	7	12	20.6	21.0	21.5	23.0
Kopaonik (1950-2022)	6	6	11.5	12.1	12.5	<u>14.0</u>
Kursumlija (1952-2022)	6	7	19.0	19.4	19.9	21.1

Krusevac (1927-2022)	5	9	20.7	21.1	21.5	23.1
Cuprija (1948-2022)	3	3	20.3	21.0	21.3	23.5
Nis (1925-2022)	6	10	21.2	21.9	22.2	23.6
Leskovac (1948-2022)	8	12	20.4	20.9	21.1	22.4
Zajecar (1929-2022)	6	10	20.9	21.8	22.0	22.6
Dimitrovgrad (1945-2022)	8	13	18.8	19.4	19.7	20.7
Vranje (1926-2022)	9	16	20.3	21.1	21.3	22.4

* Rank –period of stations work (warmest season)

** Rank – 1981-2022 period (warmest season)

Summer 2022			Precipitation sums (mm)			
Station	Rank *	Rank **	33	50	66	Observed Value
Beograd (1888-2022)	66/ 70	19/ 24	169.3	222.8	264.1	196.9
Palić (1945-2022)	32/ 53	16/ 27	161.4	197.6	219.0	156.3
Sombor (1942-2022)	7/ 86	4/ 39	180.2	187.8	215.1	<u>94.7</u>
Novi Sad (1948-2022)	26/ 53	13/30	174.5	187.8	236.8	161.3
Zrenjanin (1946-2022)	13/ 86	6/ 37	155.3	175.6	222.8	108.8
Kikinda (1948-2022)	43/ 56	18/ 25	152.4	174.9	205.7	152.2
Banatski Karlovac (1946-2022)	11/ 66	9/ 34	146.6	198.6	246.0	120.1
Loznica (1926-2022)	85/ 14	36/ 7	237.8	256.5	309.0	362.6
Sremska Mitrovica (1925-2022)	48/ 51	21/ 22	173.9	189.4	226.1	184.2
Valjevo (1926-2022)	23/ 71	13/ 30	214.0	233.9	286.7	161.4
Kragujevac (1925-2022)	65/ 27	32/ 11	154.8	195.4	230.6	235.8
Smederevska Palanka (1939-2022)	82/ 11	37/ 6	168.2	201.5	231.6	299.5

Veliko Gradište (1926-2022)	27/66	14/29	129.4	173.9	238.6	135.5
Crni Vrh (1967-2022)	24/33	23/20	169.4	196.9	249.3	200.8
Negotin (1927-2022)	49/32	25/18	105.8	138.2	188.9	152.8
Zlatibor (1950-2022)	14/60	8/35	230.7	288.4	313.0	197.7
Sjenica (1946-2022)	41/50	15/28	191.2	213.6	229.3	191.9
Pozega (1952-2022)	12/84	4/39	178.0	218.5	238.1	132.0
Kraljevo (1926-2022)	76/19	33/10	209.6	244.4	272.7	290.5
Kopaonik (1950-2022)	48/1	34/9	224.1	279.6	323.8	357.9
Kursumlija (1952-2022)	63/33	27/16	129.2	175.7	208.0	200.2
Krusevac (1927-2022)	69/24	33/10	137.0	172.5	209.9	248.8
Cuprija (1948-2022)	51/33	27/16	143.8	185.8	204.9	203.6
Nis (1925-2022)	83/12	38/5	125.9	150.2	178.7	221.3
Leskovac (1948-2022)	65/26	30/13	126.2	150.3	179.6	201.1
Zajecar (1929-2022)	64/30	32/11	115.7	156.2	172.8	193.0
Dimitrovgrad (1945-2022)	89/5	41/2	150.2	175.7	203.5	304.6
Vranje (1926-2022)	58/36	26/17	112.0	144.3	179.9	163.9

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

** Rank – 1981-2022 period (lowest/highest seasonal precipitation)

Country	Seasonal temperature JJA		Seasonal precipitation JJA		High Impact Events
	Observed	SEECOF-27 climate outlook for temperature	Observed	SEECOF-27 climate outlook for precipitation	
Serbia (1)	Above normal in entire Serbia	Above-normal (10, 20, 70) in entire Serbia	Below normal in northern and part of western Serbia Above normal in central, southeastern and part of western Serbia	Below-normal (50, 30, 20) in entire Serbia	<ul style="list-style-type: none"> ❖ 3rd warmest summer for Serbia since 1951 ❖ Warmest summer for Palic, Novi Sad, Kikinda and Banatski Karlovac ❖ 2nd warmest summer for Zrenjanin, Veliko Gradiste and Pozega ❖ 3rd warmest summer for Belgrade, Sombor, Cuprija and Crni Vrh ❖ 2nd warmest summer for Serbia based on the minimum air temperature ❖ Record-breaking number of summer and tropical days for Kikinda, Banatski Karlovac and Veliko Gradiste, in Zrenjanin and Sombor, tropical days and nights, respectively. ❖ Dry summer in parts of northern and western Serbia, rainy in parts of central and southeastern Serbia, within the average elsewhere ❖ 5th wettest summer for Dimitrovgrad and 7th driest for Sombor ❖ 2 days with precipitation of 50 mm and more are recorded in Loznica, 1 day in Novi Sad, Kragujevac, Smederevska Palanka and Zlatibor ❖

Analysis of the summer season 2022 for Serbia relative to the 1991-2020 base period

Temperature

Summer 2022 ranks as the 3rd warmest summer for Serbia in the period from 1951 to 2022 (*Figure 1*) whilst the summer of 2012 was the warmest. The summer 2022 ranks as the warmest for Palic, Novi Sad (*Figure 2*), Kikinda and Banatski Karlovac, 2nd warmest for Zrenjanin, Veliko Gradiste and Pozega, 3rd warmest for Belgrade since 1888 (*Figure 3*) as well as Sombor, Cuprija and Crni Vrh. Since the year of 2000, 15 out of 20 warmest summer seasons were registered.

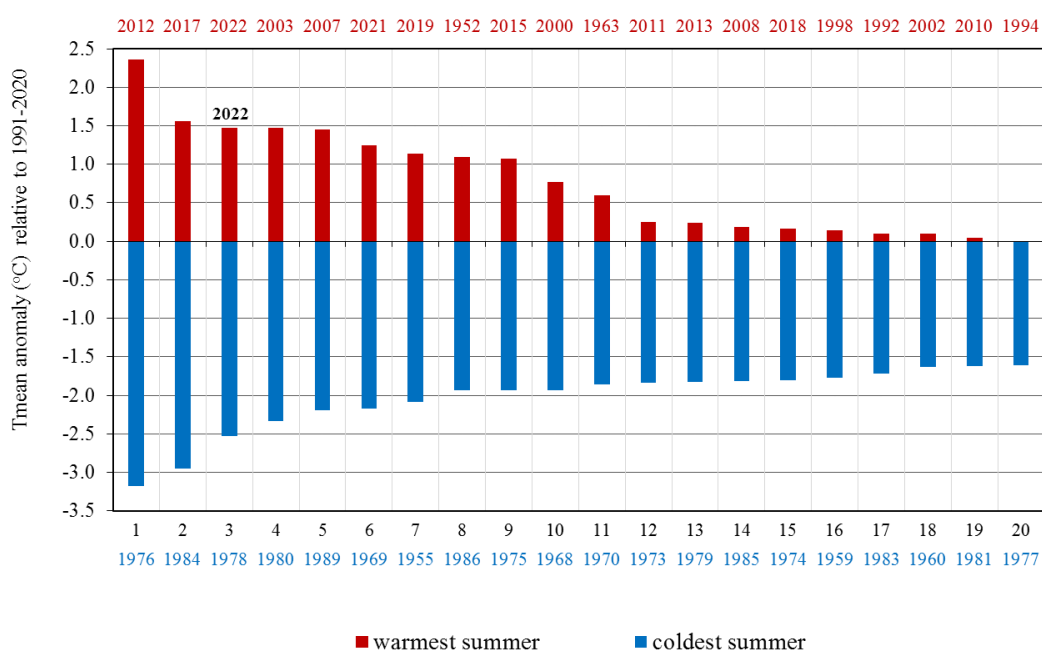
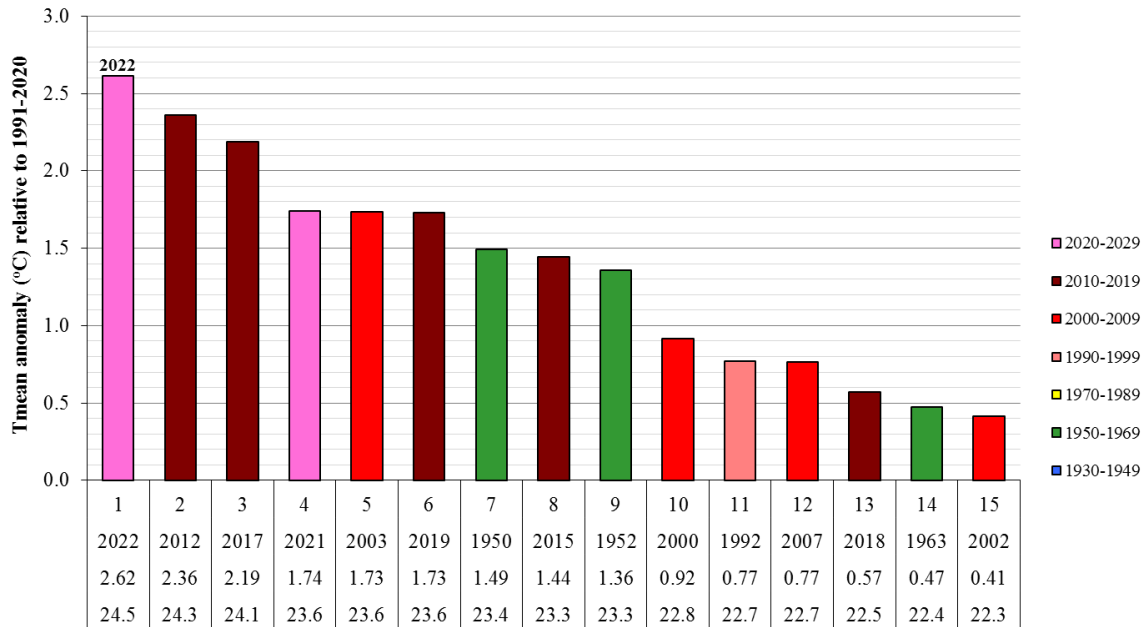


Figure 1. Rank of twenty warmest and coldest summers in Serbia for the 1951-2022 period

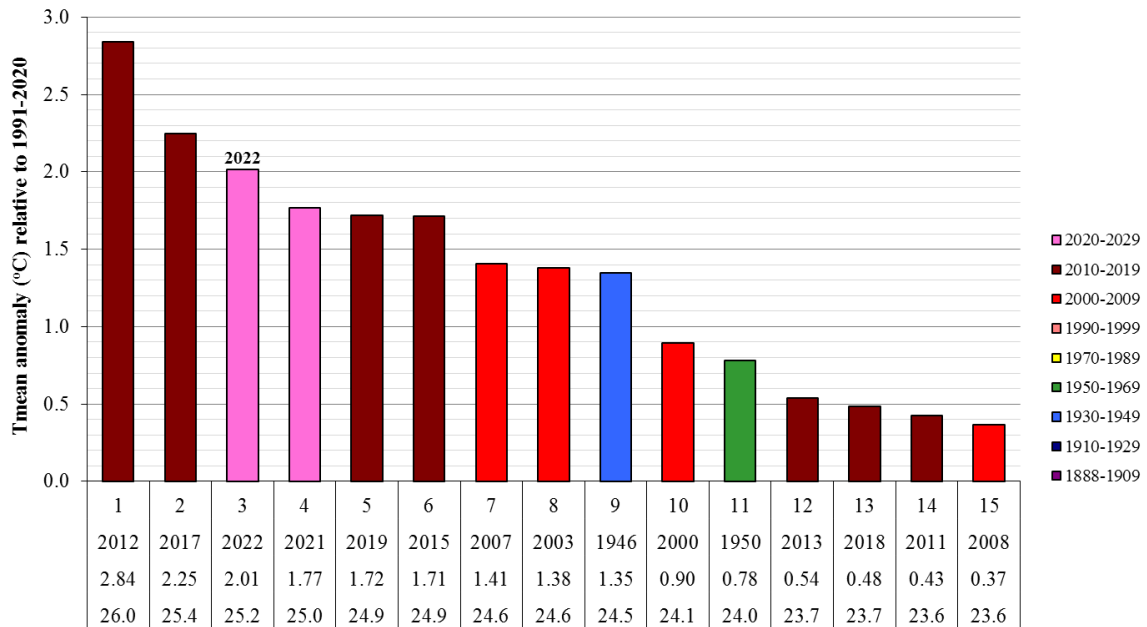
**Anomaly of mean seasonal temperature relative to 1991-2020 base period
Novi Sad - 1948-2022 period**



ranking - year - Tmean anomaly (°C) relative to 1991-2020 - Tmean

Figure 2. Rank of the warmest summers in Novi Sad

**Anomaly of mean seasonal temperature relative to 1991-2020 base period
Belgrade - 1888-2022 period**



ranking - year - Tmean anomaly (°C) relative to 1991-2020 - Tmean

Figure 3. Rank of the warmest summers in Belgrade

Mean summer air temperature ranged from 20,7°C in Dimitrovgrad to 25,2°C in Belgrade, and on the mountains from 14,0°C at Kopaonik to 18,9°C at Zlatibor (*Figure 4*).

Departure of the mean summer air temperature from the normal¹ ranged from +0,7°C in Dimitrovgrad and Zajecar to +2,6°C in Novi Sad, and on the mountains from +1,1°C in Sjenica to +1,8°C at Crni Vrh (*Figure 5*).

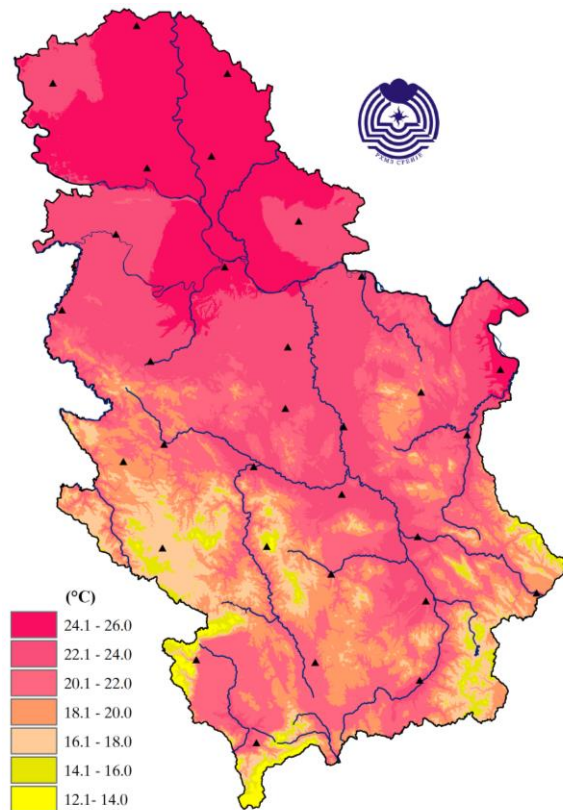


Figure 4. Spatial distribution of mean summer air temperature

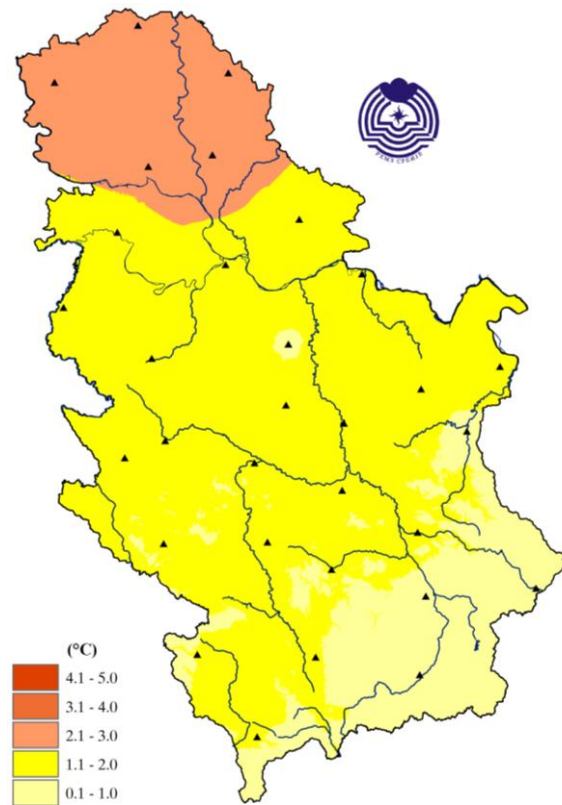


Figure 5. Spatial distribution of mean summer air temperature anomaly from the normal

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, 1991 to December 31, 2020

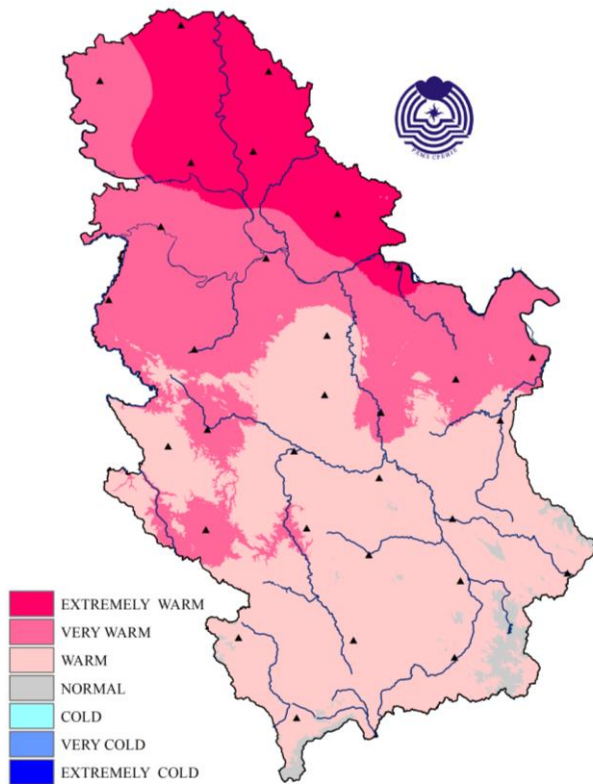


Figure 6. Spatial distribution of mean summer air temperature according to the percentile method

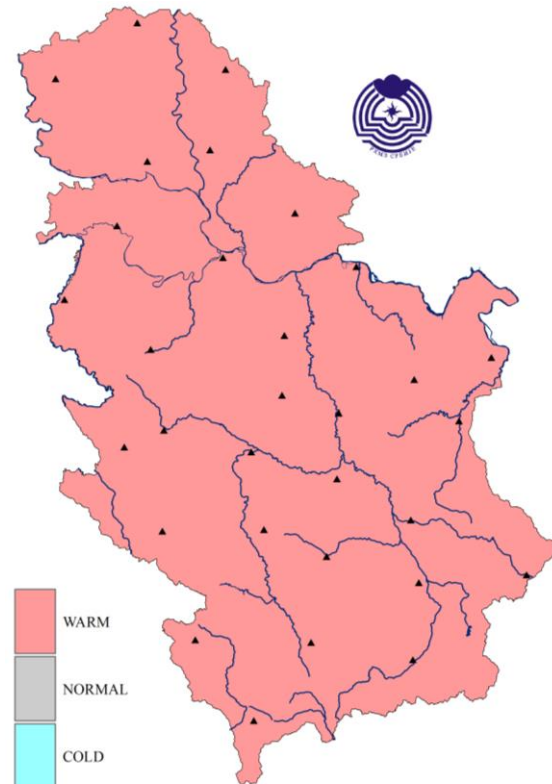


Figure 7. Spatial distribution of mean summer air temperature according to the tercile method

Based on the percentile method², mean summer air temperature in northern, western and eastern parts of Serbia was in the very warm and extremely warm categories, elsewhere it fell under warm category (*Figure 6*).

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

The highest summer daily air temperature of 40,6°C was measured in Banatski Karlovac on July 23.

The lowest summer air temperature of 1,7°C was measured in Sjenica on July 12. The same day, in the lowland air temperature of 5,6°C 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 days³ ranged from 77 in Kursumlija to 90 in Veliko Gradiste and Negotin, on the mountains, from 3 at Kopaonik to 49 in Sjenica. Record-breaking number of summer days was observed in Kikinda, Banatski Karlovac and Veliko Gradiste. Departure of the number of summer days was above the average across the entire country (Figure 8) ranging from 1 at Kopaonik to 15 days above the average on Palic, Sombor and Zrenjanin. Belgrade saw 86 summer days, which is 12 days above the average.

Number of tropical days⁴ ranged from 42 in Dimitrovgrad to 67 in Veliko Gradiste, and on the mountains, from 0 at Kopaonik to 9 in Sjenica. Record-breaking number of tropical days was registered in Zrenjanin, Kikinda, Banatski Karlovac and Veliko Gradiste. Belgrade saw 56 tropical days. The observed number of tropical days was above the average, ranging from 6 days in Kragujevac to 26 days above the average in Veliko Gradiste (Figure 9), and 1 day below the average on Zlatibor.

Belgrade recorded 39 tropical nights⁵, which is 15 nights above the average, and in the upland, 4 days at Crni Vrh, which is 1 day above the summer average. Record-breaking number of tropical nights was registered in Sombor. Pozega, Sjenica, Dimitrovgrad, Vranje, Kursumlija and Kopaonik didn't observe any tropical nights.

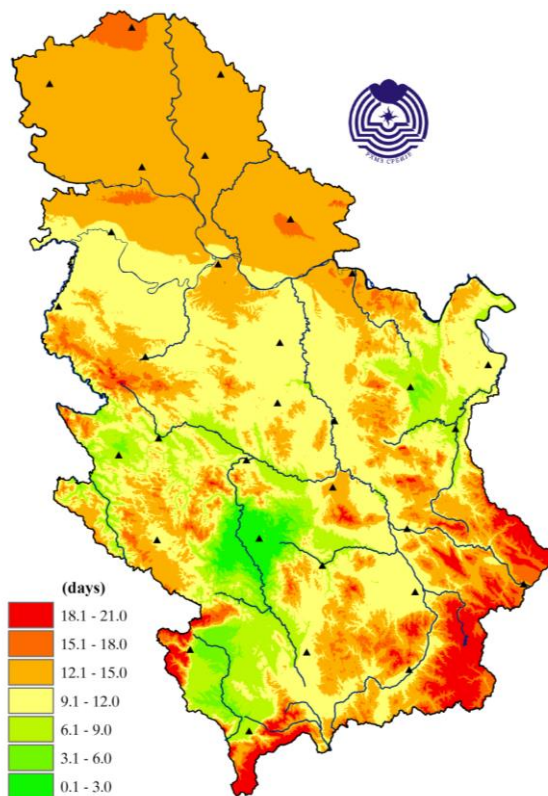


Figure 8. Deviation of the number of summer days from the normal

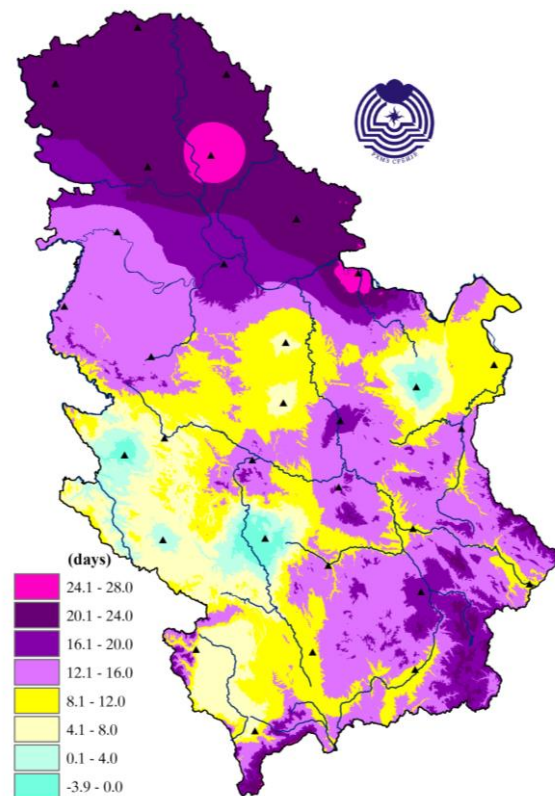


Figure 9. Deviation of the number of tropical days from the normal

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

In Belgrade, mean, maximum and minimum air temperature were above the multiannual average at the beginning and end of June, most of July and August, and below the average at the end of June, middle of July and last decade of August (Figure 10).

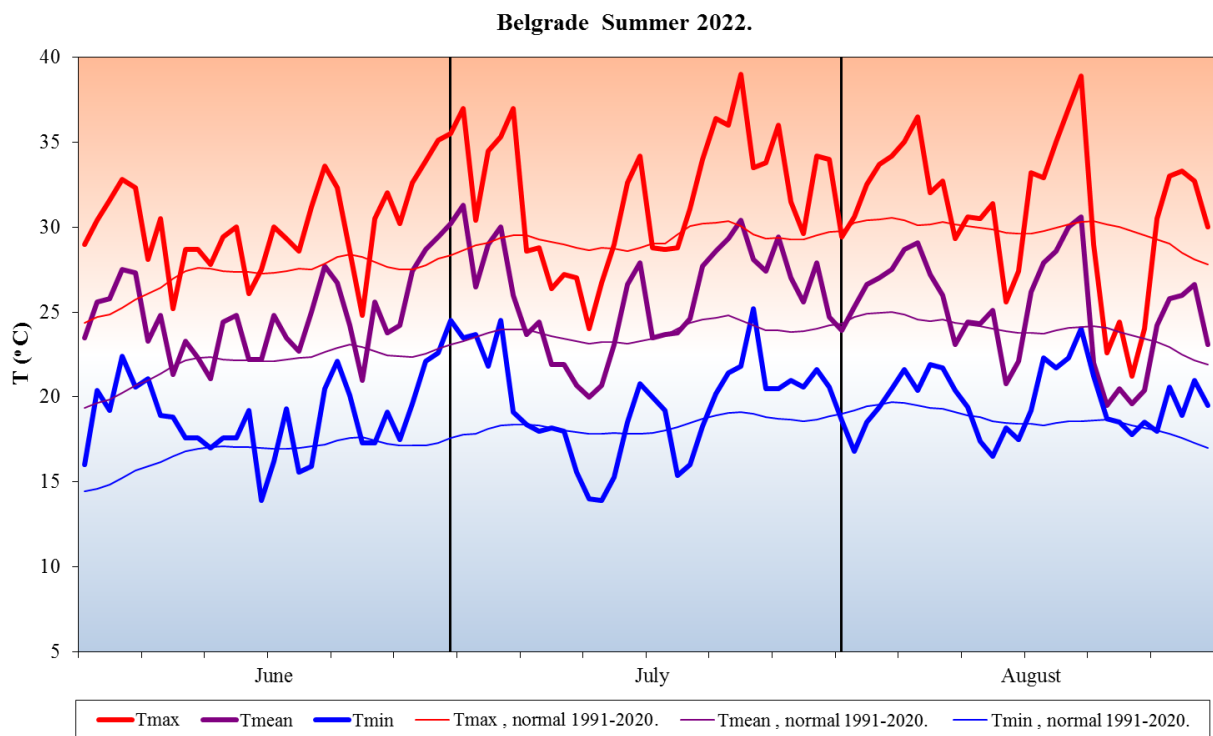


Figure 10. Three – month course of mean, maximum and minimum daily air temperature in Belgrade

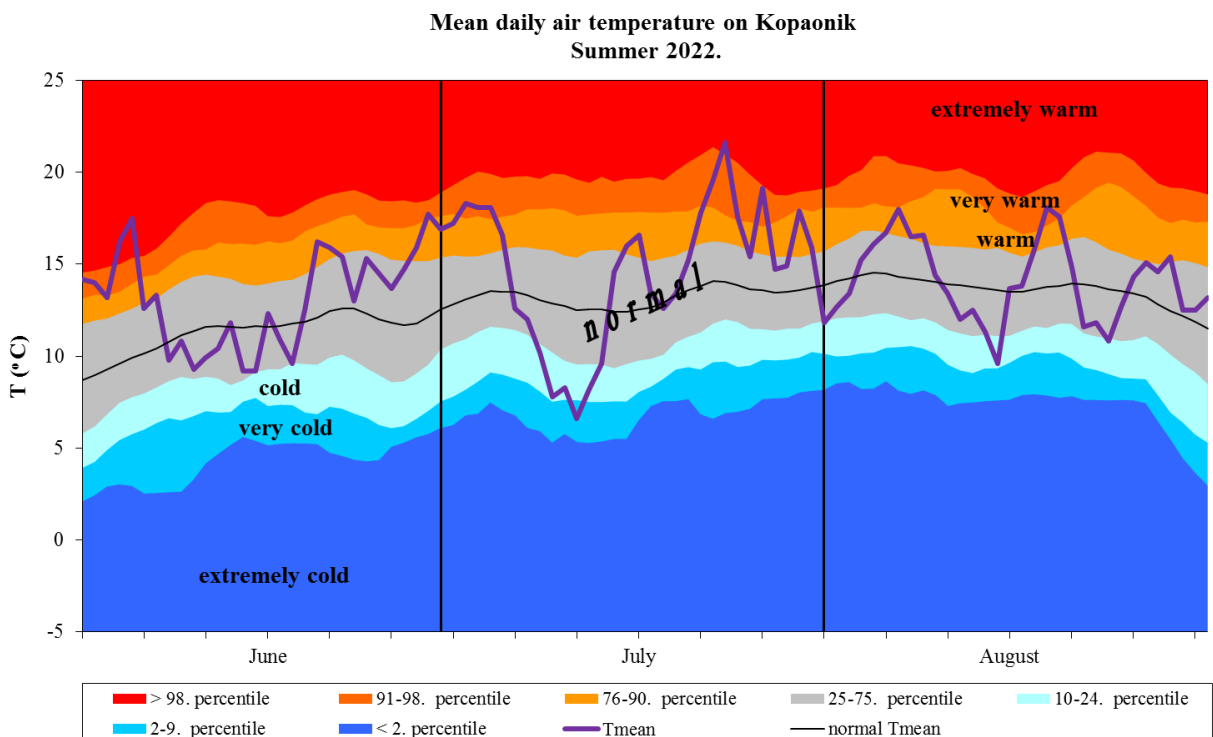


Figure 11. Three – month course of mean daily air temperature at Kopaonik

Figures 12 and 12 show assessment of the mean, maximum and minimum air temperature and precipitation sums for Serbia for summer based on the tercile relative to the 1981-2010 base period. It can be noted that the summer 2022 was the 2nd warmest summer with the minimum air temperature, and 4th warmest summer with the maximum air temperature. Precipitation sums were within the average.

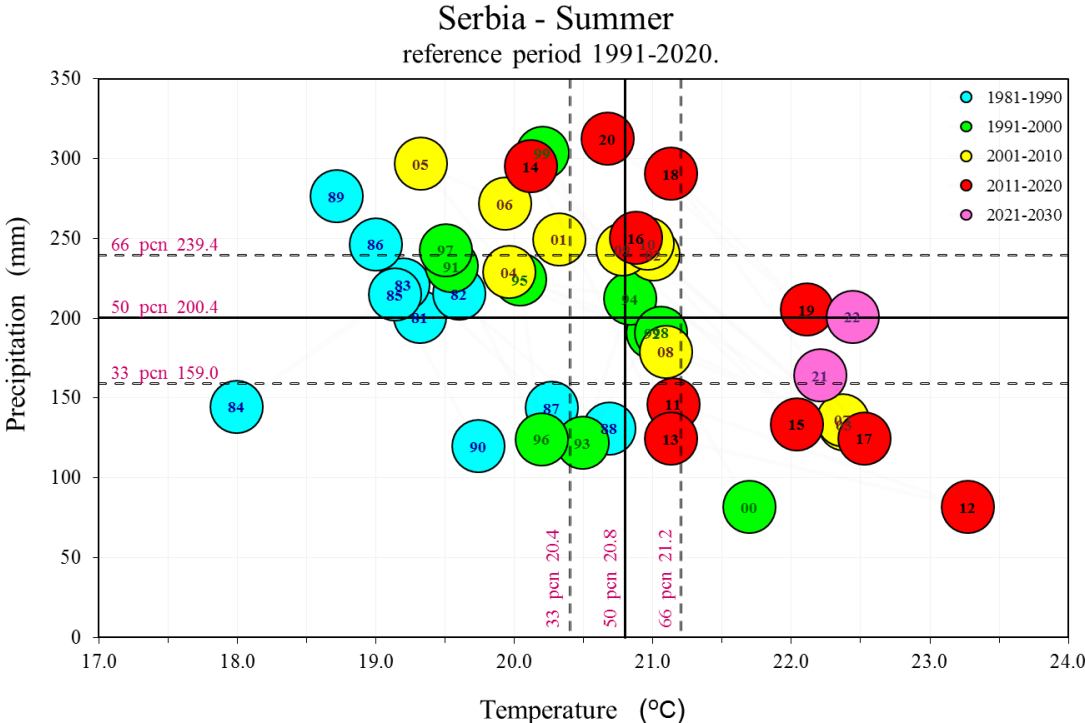


Figure 12. Assessment of precipitation sums and mean air temperature for summer in Serbia based on the accompanying terciles relative to the 1991-2020 base period

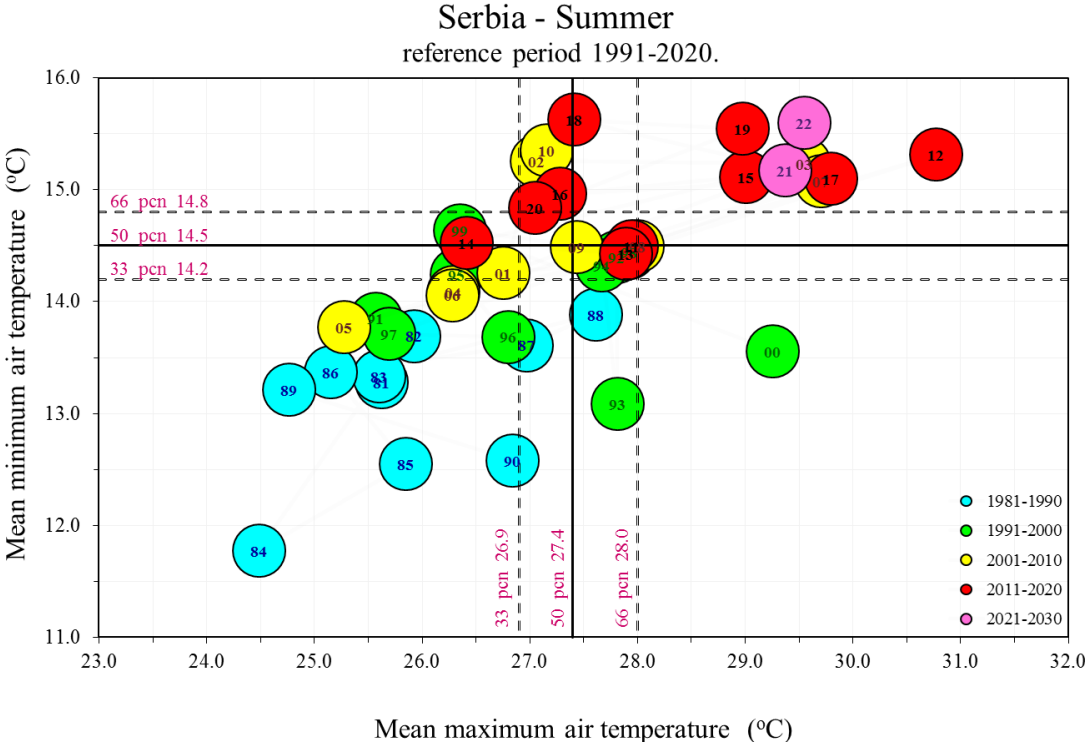


Figure 13. Assessment of maximum and minimum air temperature for summer in Serbia based on the accompanying terciles relative to the 1991-2020 base period

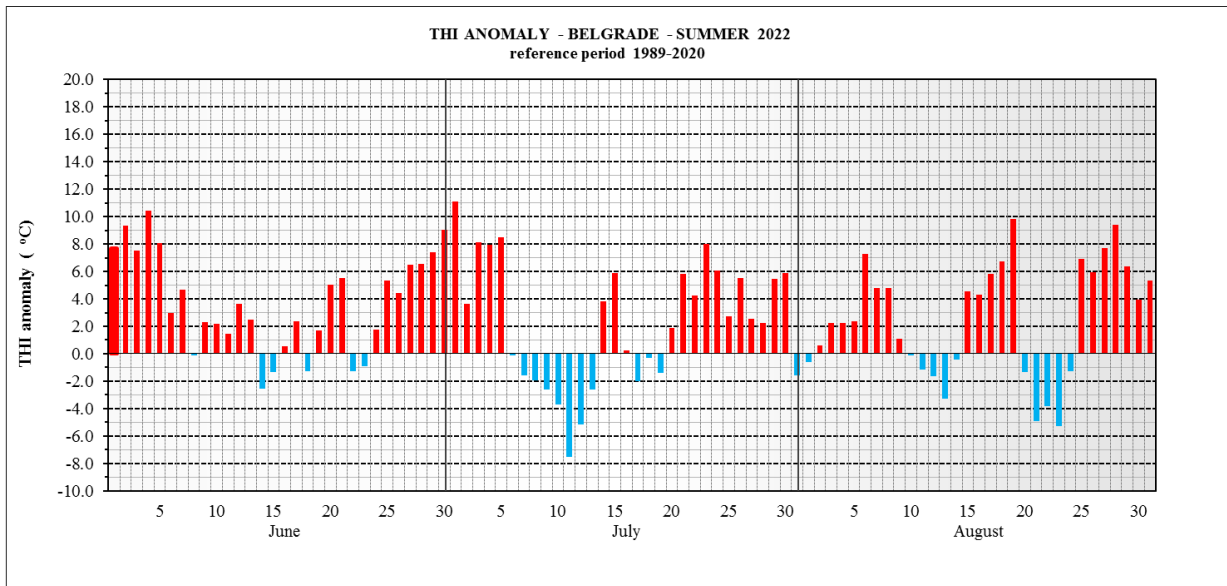


Figure 14.

Departure of the Temperature Heat Index (THI)⁶ was positive most of summer (Figure 14). The highest difference between the feel like temperature and maximum daily air temperature was observed on August 28 measuring 7,5°C (Figure 15). On that day, the maximum air temperature was 32,7°C whilst feel good temperature was 40,2°C. The maximum summer THI was 43,3°C was measured on August 19, 2022. There were 10 days with the THI above 40°C and 79 days with temperature above 30°C.

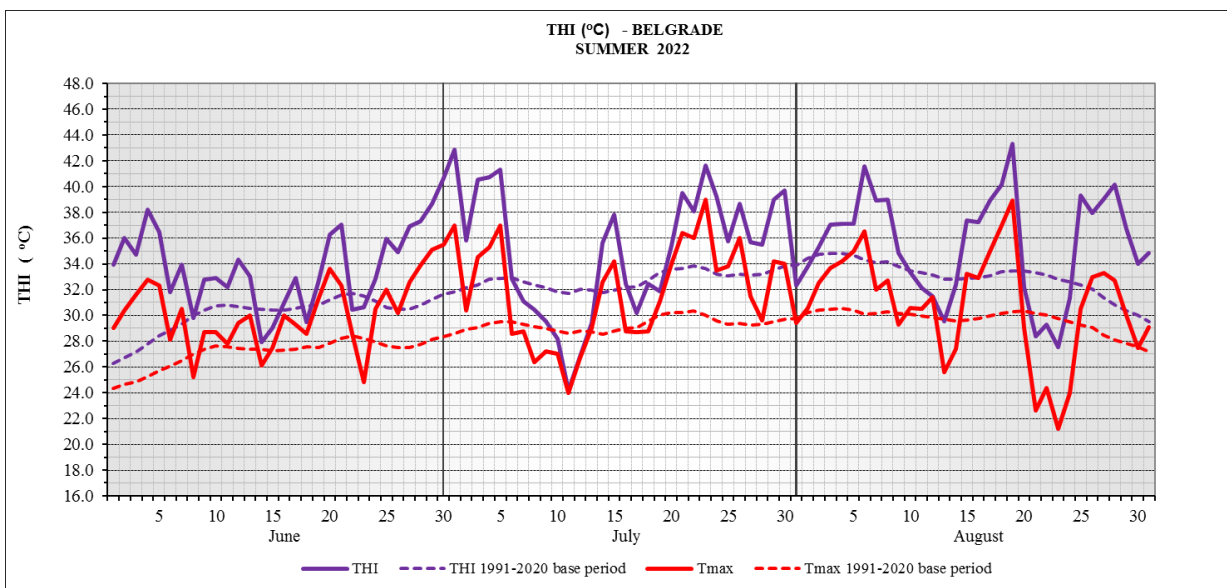


Figure 15.

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

Precipitation

Summer precipitation sums in Serbia ranged from 94,7 mm in Sombor to 362,6 mm in Loznica (Figure 16). Precipitation sums relative to the normal ranged from 45% in Sombor to 164% in Dimitrovgrad (Figure 17).

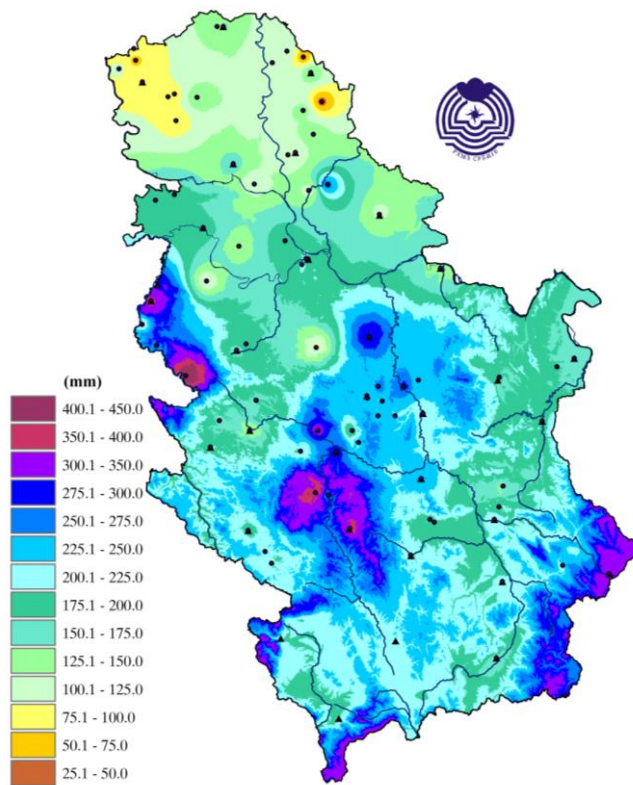


Figure 16. Spatial distribution of summer precipitation sums based on data from 28 principal, 12 climatological and 43 rain gauge stations

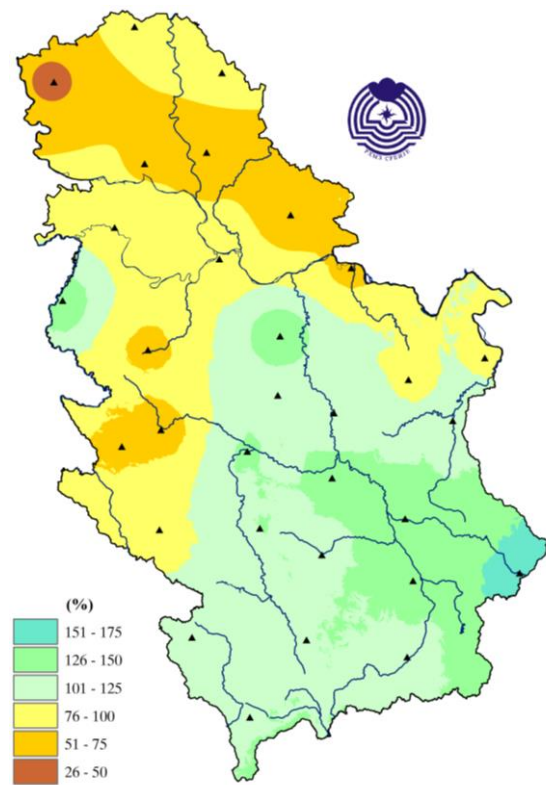


Figure 17. Spatial distribution of summer precipitation sums in percentage of normal

Based on the percentile method, summer precipitation sums were in the following categories: normal category in most of Serbia, dry category in Zrenjanin, Valjevo and Zlatibor, very dry in Sombor and Pozega, rainy in Loznica, Smederevska Palanka, Kraljevo, Kopaonik and Kurusmlija, and very rainy in Nis and Dimitrovgrad (Figure 18).

Based on the tercile method, precipitation sums were in the dry category in parts of northern and western Serbia, rainy category in parts of central and southeastern Serbia, elsewhere it was in the normal category (Figure 19).

The highest daily precipitation sum of 76,4 mm was recorded in Loznica on June 11.

The summer of 2022 was the **5th warmest** for Dimitrovgrad (Figure 20) since 1926 and the **7th driest** for Sombor (Figure 21) since 1931.

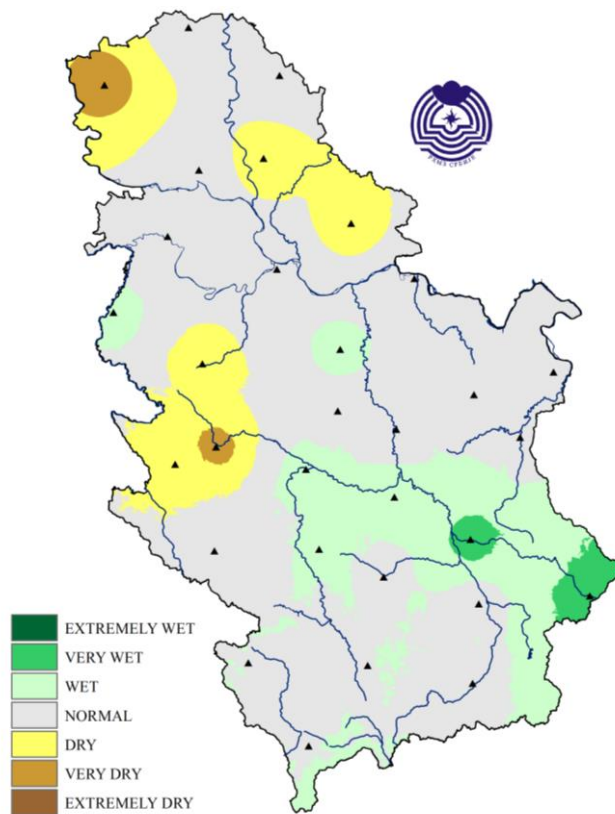


Figure 18. Summer precipitation sums according to the percentile method

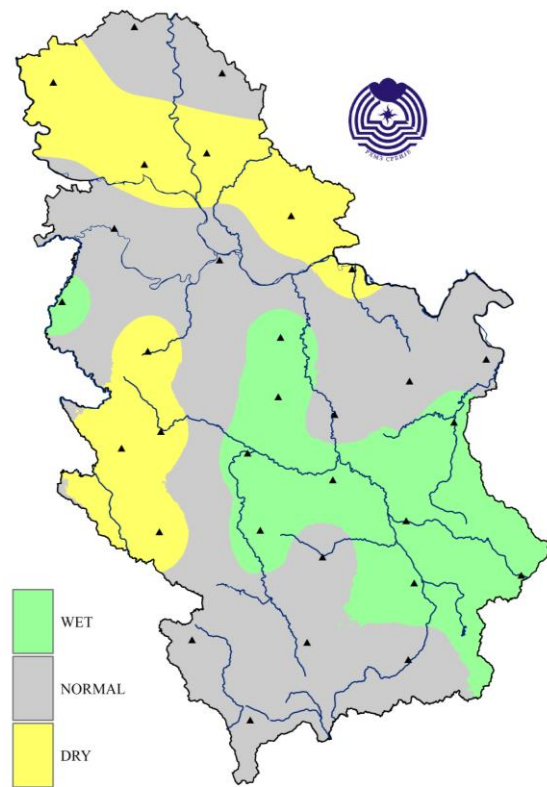


Figure 19. Summer precipitation sums according to the tercile method

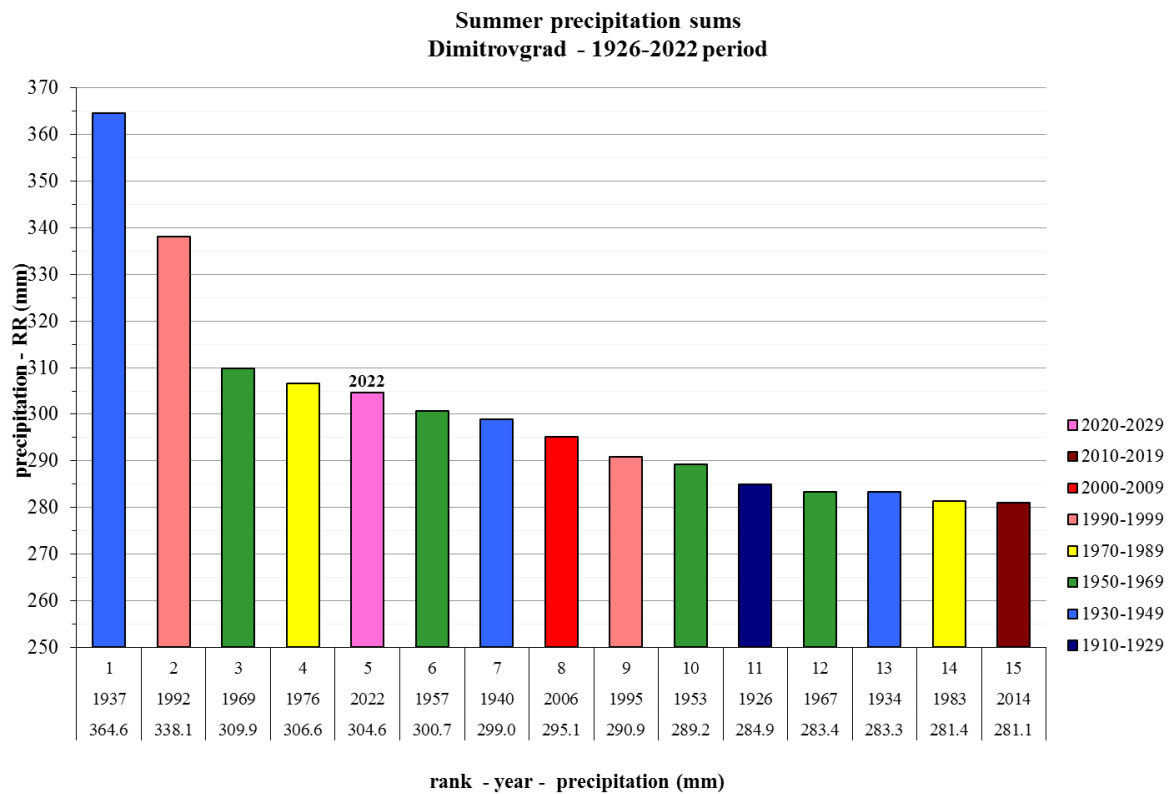


Figure 20. Rank of the wettest summers in Dimitrovgrad

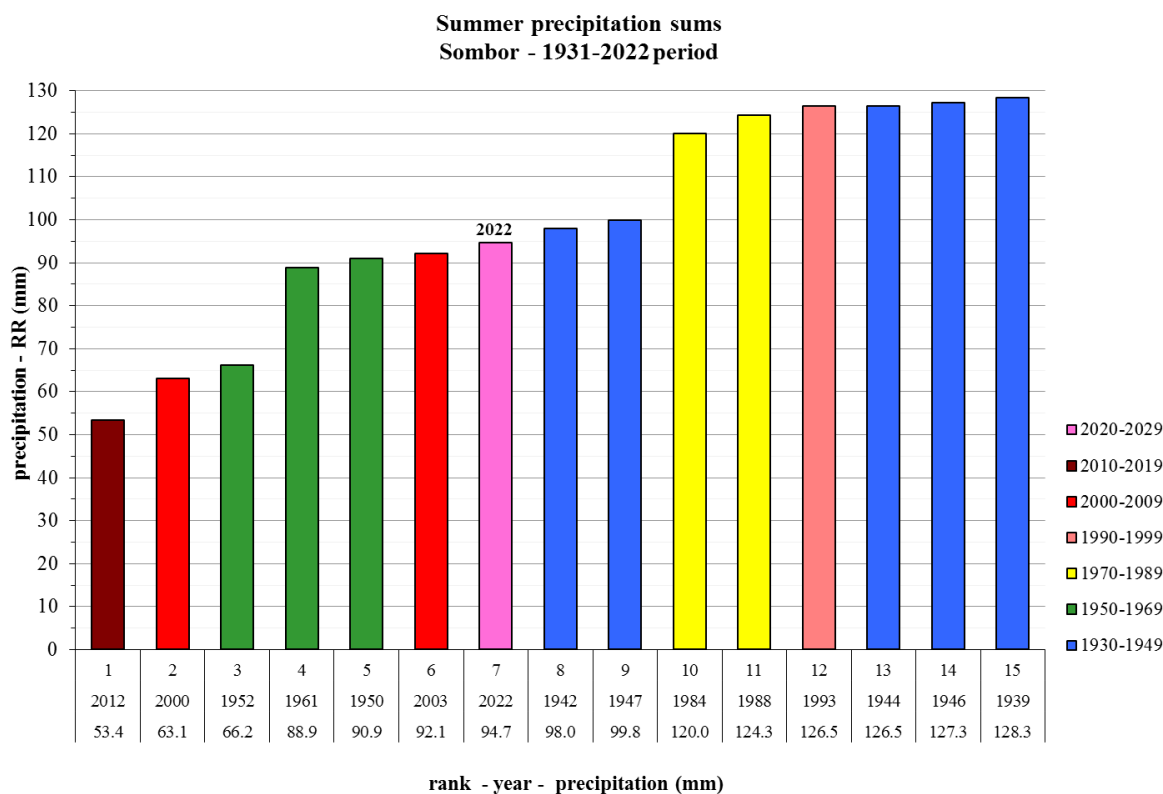


Figure 21. Rank of the driest summers in Sombor

Number of days with precipitation recorded during summer 2022, ranged from 19 days in Zrenjanin to 38 days in Kraljevo and Kopaonik. The recorded number of days was below the average in most of Serbia, up to 11 days below the average in Belgrade, with 20 recorded days during summer (Figure 22). Number of days with precipitation was above the average in the southern, eastern and parts of central Serbia.

Entire Serbia, apart from Sombor saw days with daily precipitation sum of 20 mm and above, up to 6 days in Loznica and Kopaonik which is up to 2 days above the summer average (Figure 23).

2 days with precipitation sums of 50 mm and above were registered in Loznica, 1 day in Novi Sad, Kragujevac, Smederevska Palanka and Zlatibor.

In summer, number of thunder days (Figure 24) ranged from 11 in Sombor and Banatski Karlovac, 7 days below the average, up to 35 days in Leskovac, which is 14 days above the average.

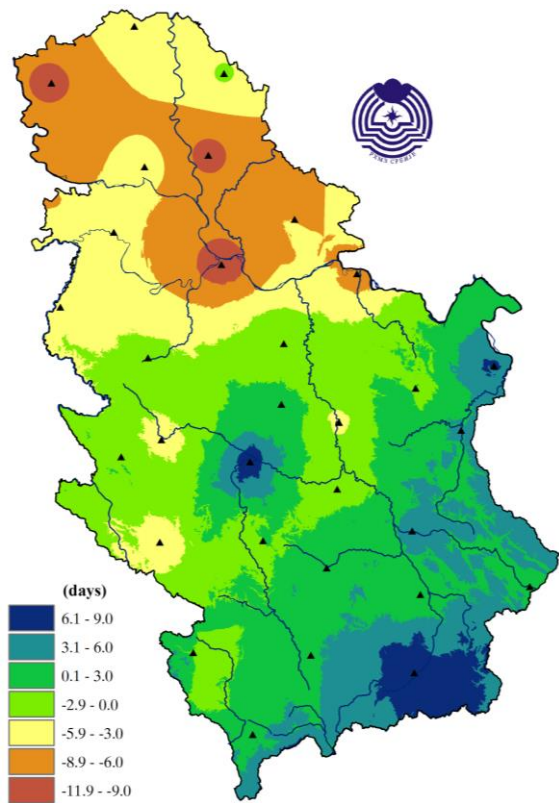


Figure 22. Deviation of number of days with precipitation of 0.1 mm and more from the normal

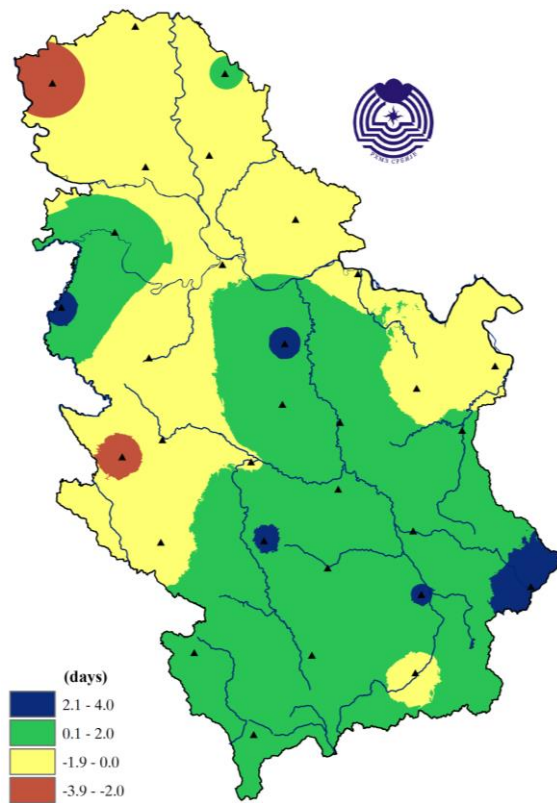


Figure 23. Deviation of number of days with precipitation of 20 mm and more from the normal

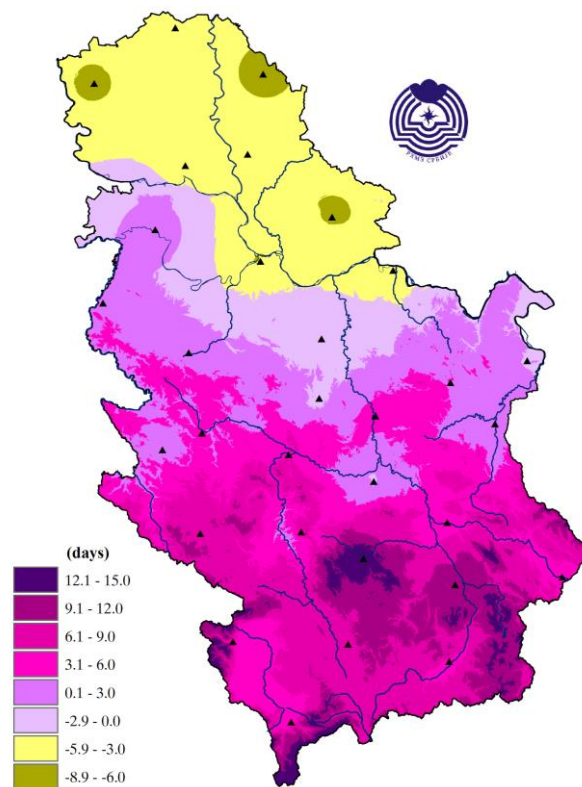


Figure 24. Deviation of number of days with thunder from the normal

Figures 25 and 26 show cumulative precipitation sums for Dimitrovgrad and Nis during summer per months relative to the average cumulative precipitation sums.

Cumulative precipitation sums in Dimitrovgrad

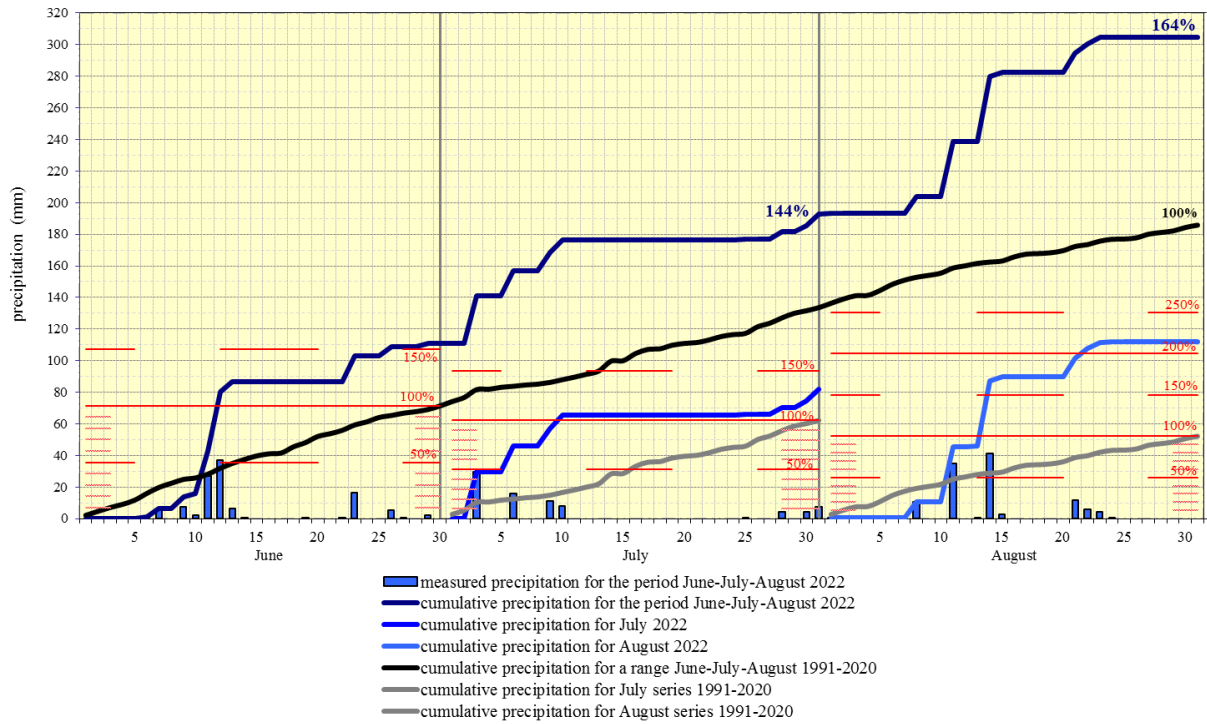


Figure 25. Cumulative precipitation sums for Dimitrovgrad

Cumulative precipitation sums in Nis

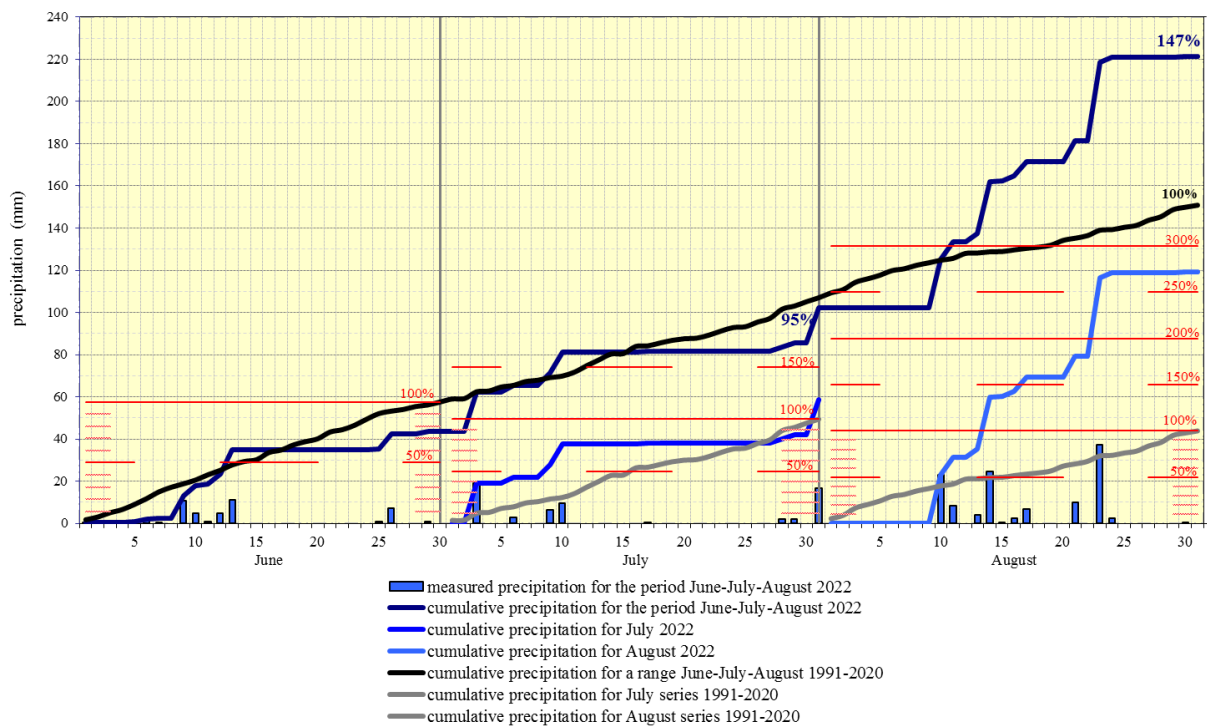


Figure 26. Cumulative precipitation sums for Nis

Sunshine duration (insolation)

During 2022 summer season, sunshine duration ranged from 762 hours in Zajecar to 990 hours in Novi Sad (*Figure 27*).

Relative to the normal for the 1991-2020 base period, insolation ranged from 95% in Zajecar to 117% in Pozega (*Figure 28*).

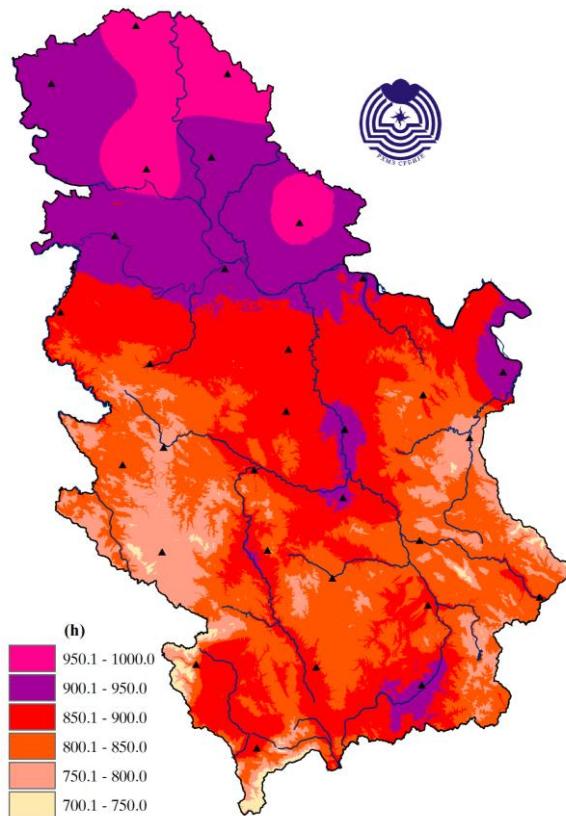


Figure 27. Insolation in hours

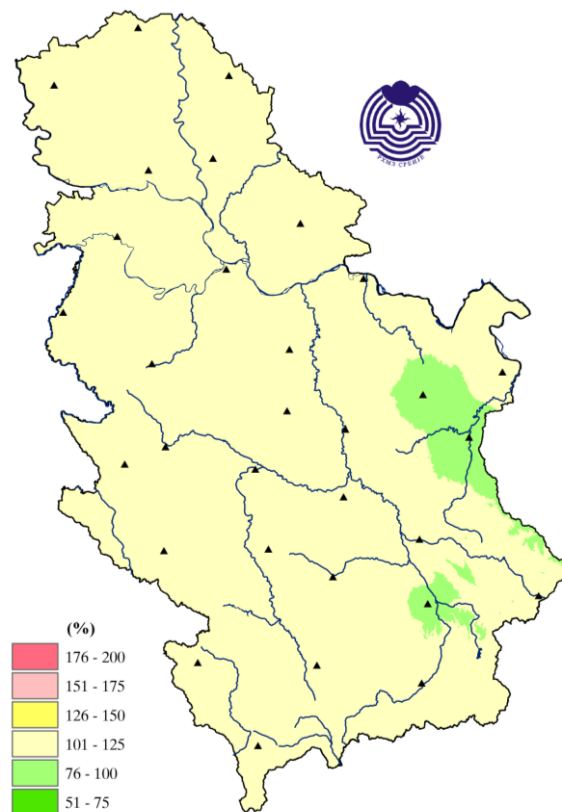


Figure 28. Insolation in percentage of normal

Analysis of the summer season 2022 for Serbia relative to the 1961-1990 base period

Temperature

During summer 2022, departure of the mean air temperature from the normal for the 1961-1990 base period, range from +2,0°C in Dimitrovgrad to +4,2°C in Zrenjanin and Belgrade, and on the mountains from +2,9°C in Sjenica to +3,3°C at Kopaonik (Figure 29).

Based on the percentile method, mean summer air temperature was in the extremely warm category across the entire country (Figure 30).

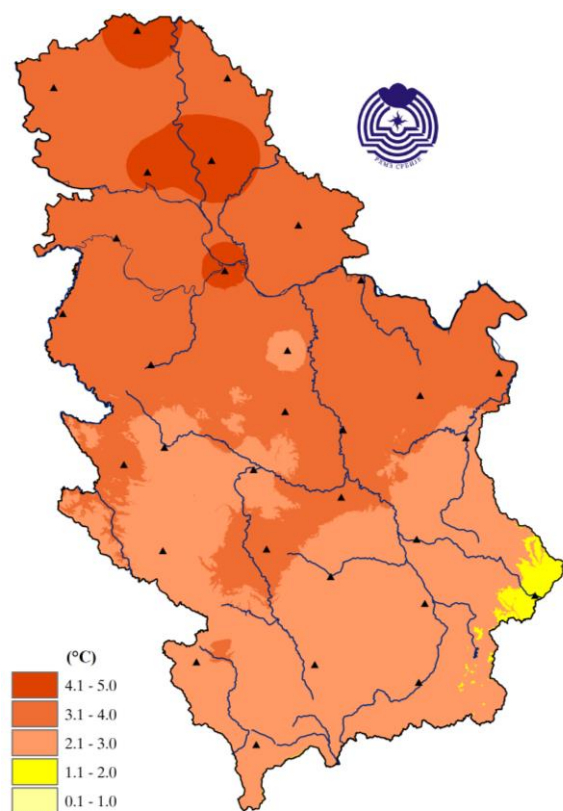


Figure 29. Spatial distribution of mean summer air temperature anomaly from the 1961-1990 normal

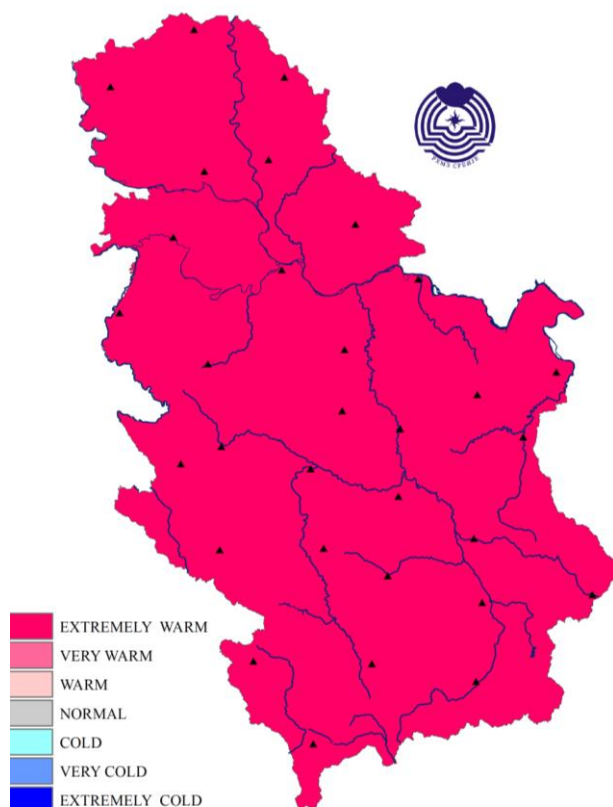


Figure 30. Spatial distribution of mean summer air temperature according to the percentile method

Precipitation

Summer precipitation sums relative to the normal for the 1961-1990 base period ranged from 49% in Sombor to 159% in Dimitrovgrad (*Figure 31*).

Based on the percentile method, summer precipitation totals were in the normal category in most of Serbia, dry and very dry category in northern and western Serbia, and rainy and very rainy in parts of southeastern and central Serbia (*Figure 32*).

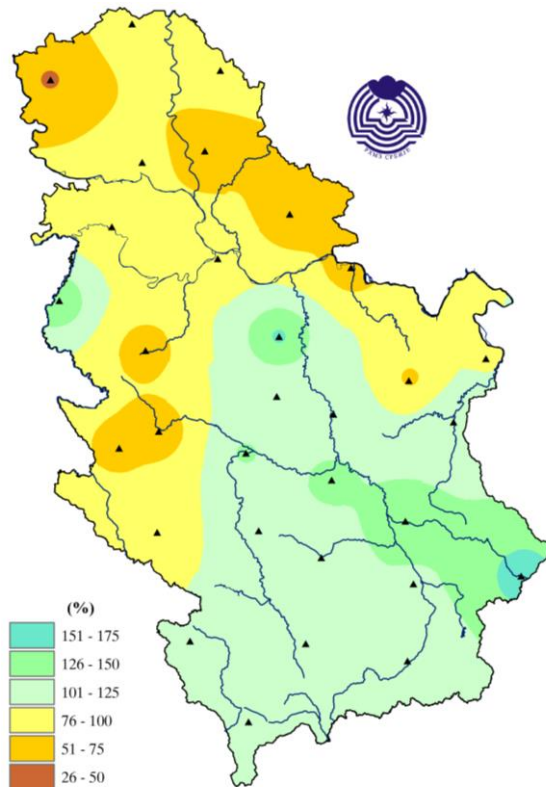


Figure 31. Spatial distribution of spring precipitation sums in percentage of the 1961-1990 normal

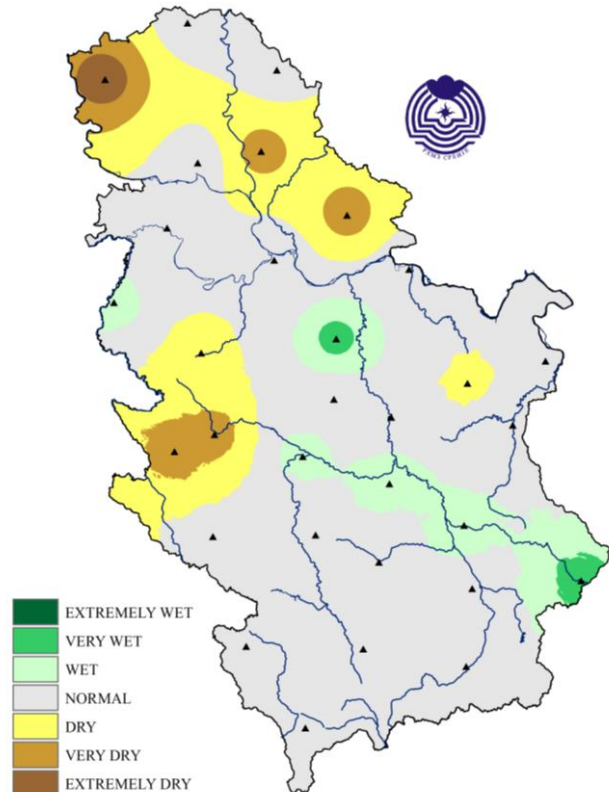


Figure 32. Summer precipitation sums according to the percentile method

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