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VERIFICATION OF THE SEECOF–15 SUMMER 2016 CLIMATE OUTLOOK FOR THE TERRITORY OF SERBIA COMPARED TO THE 1981–2010 BASE PERIOD

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Temperature

According to the SEECOF-15 outlook for the summer 2016 in Serbia, above-normal to near-normal temperature in Serbia was indicated, compared to the 1981–2010 climatological base period.

Climatological monitoring showed that the summer 2016 was warm in almost entire Serbia with above-normal temperature based on the tercile method (*Figure* 1).

The outlook for a warm summer was correct. Verification showed that the temperature reached upper tercile in most part of Serbia which was indicated in the outlook with the 40% probability.

Precipitation

The SEECOF–15 climate outlook for the summer 2016 in Serbia indicated approximately equal probabilities for below, near and above-average conditions.

Monitoring of precipitation showed wet summer conditions in most of Serbia (*Figure* 2).

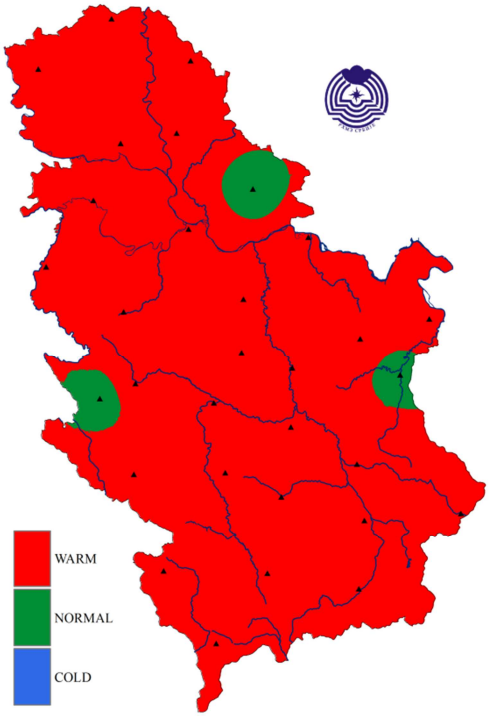


Figure 1. Monitoring of the summer 2016 temperature in Serbia using tercile method, compared to the 1981-2010 base period

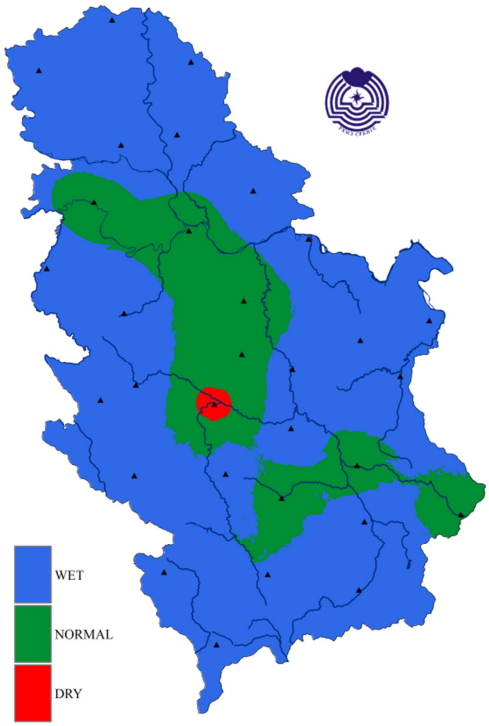


Figure 2. Monitoring of the summer 2016 precipitation in Serbia using tercile method, compared to the 1981-2010 base period

Summer 2016			Air Temperature (°C)			
Station	Rank*	Rank**	33	50	66	Observed value
Belgrade (1888-2016)	21	15	21.6	22.0	22.9	23.0
Palic (1946-2016)	18	14	20.9	21.3	21.9	22.0
Sombor (1942-2016)	19	16	20.6	21.0	21.3	21.6
Novi Sad (1949-2016)	15	13	20.8	21.0	21.6	21.8
Zrenjanin (1944-2016)	18	14	21.0	21.2	21.7	22.1
Kikinda (1949-2016)	16	13	20.8	21.3	21.7	22.0
Banatski Karlovac (1986-2016)	15	15	20.9	21.3	21.8	21.7
Loznica (1923-2016)	10	9	20.7	21.0	21.7	22.0
Sremska Mitrovica (1926-2016)	25	14	20.5	20.8	21.2	21.5
Valjevo (1927-2016)	15	9	20.5	20.9	21.6	21.9
Kragujevac (1926-2016)	26	14	20.6	21.2	21.6	21.6
Smederevska Palanka (1940-2016)	17	13	20.8	21.3	21.8	21.9
Veliko Gradiste (1927-2016)	24	14	20.4	21.1	21.4	21.6
Crni Vrh (1967-2015)	10	11	15.9	16.3	16.6	16.9
Negotin (1928-2016)	14	9	22.0	22.7	23.1	23.6
Zlatibor (1951-2016)	19	16	16.3	16.8	17.3	17.2
Sjenica (1947-2016)	14	11	15.3	15.9	16.2	16.5
Pozega (1953-2016)	14	12	18.9	19.4	19.5	19.9
Kraljevo (1927-2016)	19	10	20.6	21.0	21.5	21.7
Kopaonik (1950-2015)	13	11	11.5	12.1	12.5	12.8
Kursumlija (1953-2016)	8	7	19.0	19.4	19.9	20.2
Krusevac (1931-2016)	25	15	20.7	21.1	21.5	21.5

Cuprija (1949-2016)	15	12	20.3	21.0	21.3	21.6
Nis (1926-2016)	21	12	21.2	21.9	22.2	22.4
Leskovac (1949-2016)	15	11	20.4	20.9	21.1	21.7
Zajecar (1930-2016)	34	21	20.9	21.8	22.0	21.4
Dimitrovgrad (1946-2016)	12	6	18.8	19.4	19.7	20.5
Vranje (1927-2016)	26	14	20.3	21.1	21.3	21.5

*Rank –period of stations work (warmest season)
**Rank – 1981-2016 period (warmest season)

Summer 2016			Precipitation sums (mm)			
Station	Rank*	Rank**	33	50	66	Observed Value
Belgrade (1888-2016)	39	15	169.3	222.8	264.1	248.0
Palic (1945-2016)	20	11	161.4	197.6	219.0	225.4
Sombor (1942-2016)	11	5	180.2	187.8	215.1	297.9
Novi Sad (1948-2016)	20	12	174.5	187.8	236.8	257.4
Zrenjanin (1946-2016)	3	2	155.3	175.6	222.8	343.8
Kikinda (1948-2016)	20	6	152.4	174.9	205.7	236.3
Banatski Karlovac (1946-2015)	16	8	146.6	198.6	246.0	273.0
Loznica (1925-2016)	17	7	237.8	256.5	309.0	345.0
Sremska Mitrovica (1925-2016)	47	18	173.9	189.4	226.1	184.2
Valjevo (1926-2016)	19	10	214.0	233.9	286.7	323.0
Kragujevac (1925-2016)	41	17	154.8	195.4	230.6	202.9
Smederevska Palanka (1939-2016)	43	17	168.2	201.5	231.6	196.0

Veliko Gradiste (1926-2016)	13	6	129.4	173.9	238.6	310.4
Crni Vrh (1967-2016)	22	12	169.4	196.9	249.3	252.8
Negotin (1927-2016)	21	11	105.8	138.2	188.9	192.8
Zlatibor (1950-2016)	9	5	230.7	288.4	313.0	399.5
Sjenica (1946-2016)	12	3	191.2	213.6	229.3	286.6
Pozega (1952-2016)	11	5	178.0	218.5	238.1	327.4
Kraljevo (1926-2016)	71	28	209.6	244.4	272.7	141.1
Kopaonik (1950-2016)	11	6	224.1	279.6	323.8	364.9
Kursumlija (1952-2016)	30	13	129.2	175.7	208.0	198.4
Krusevac (1927-2015)	19	6	137.0	172.5	209.9	250.0
Cuprija (1948-2016)	25	11	143.8	185.8	204.9	213.1
Nis (1925-2016)	40	16	125.9	150.2	178.7	157.1
Leskovac (1948-2016)	20	9	126.2	150.3	179.6	206.1
Zajecar (1929-2015)	33	10	115.7	156.2	172.8	182.1
Dimitrovgrad (1945-2016)	47	17	150.2	175.7	203.5	175.9
Vranje (1926-2016)	20	9	112.0	144.3	179.9	210.9

*Rank –period of stations work (highest seasonal precipitation)
**Rank – 1981-2016 period (highest seasonal precipitation)

Country	Seasonal temperature JJA		Seasonal precipitation JJA		High Impact Events*
	Observed	SEECOF-15 climate outlook for temperature	Observed	SEECOF-15 climate outlook for precipitation	
Serbia (1)	Above normal in most parts of Serbia	**Above to near-normal** (20, 40, 40) in entire Serbia	Above normal in most parts of Serbia	**No predictive signal** (33, 34, 33) in entire Serbia	June 2016 was the fifth warmest on record in Serbia. Record-breaking number of tropical nights in June was registered at 8 main meteorological stations. Zrenjanin observed highest June precipitation total on record. July 2016 was the third wettest on record in Negotin, Leskovac and Vranje. August 2016 was the second wettest on record on Zlatibor and Pozega, and fourth wettest in Banatski Karlovac. During summer 2016, only one heat wave was registered in in the period from 17 to 25 June in Vranje and Dimitrovgrad. It was the third wettest summer on record in Zrenjanin.

Warm summer 2016 across most of Serbia, in northern parts of the country averagely warm. Third wettest summer on record in Zrenjanin. Above-average precipitation sums in northern Serbia, below-average in central parts of the country.

Analysis of the 2016 summer season for Serbia compared to the 1981-2010 base period

Temperature

Mean summer air temperature ranged from 19.9°C in Pozega to 23.6°C in Negotin, and in the mountain regions from 12.8°C at Kopaonik to 17.2°C on Zlatibor (*Figure 1*).

Departure of the mean air temperature from the normal[1], in summer for the 1981–2010 base period ranged from -0.1ºC in Zajecar to 1.2ºC in Dimitrovgrad, and in the high-lying areas from 0.4°C on Zlatibor to 0.8°C at Kopaonik (*Figure 2*).

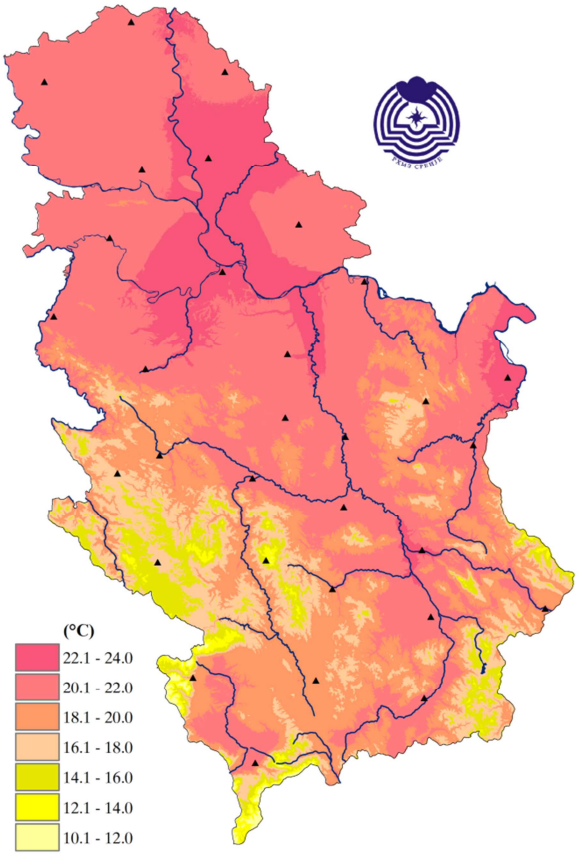


Figure 1. Spatial distribution of the mean seasonal air temperature (°C) during summer

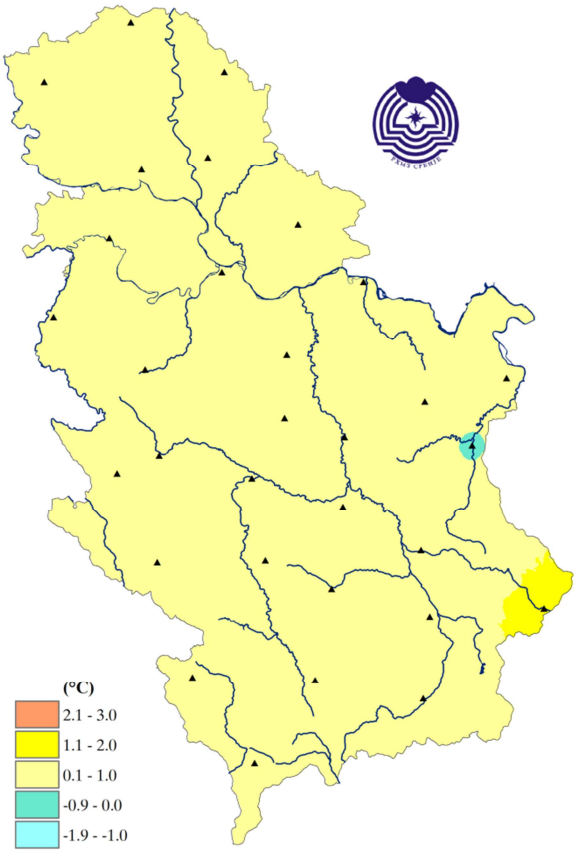


Figure 2. Mean seasonal air temperature anomaly in Serbia during summer compared to the 1981-2010 base period

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

Based on the percentile method[2], mean summer air temperature was in the normal category in northern areas, and in central and southern parts of Serbia in warm and very warm category (*Figure 3*).

Based on tercile method, mean summer air temperature was in the warm category in almost entire Serbia, apart from Banatski Karlovac, Zajecar and Kopaonik where it was in the normal category (*Figure 4*).

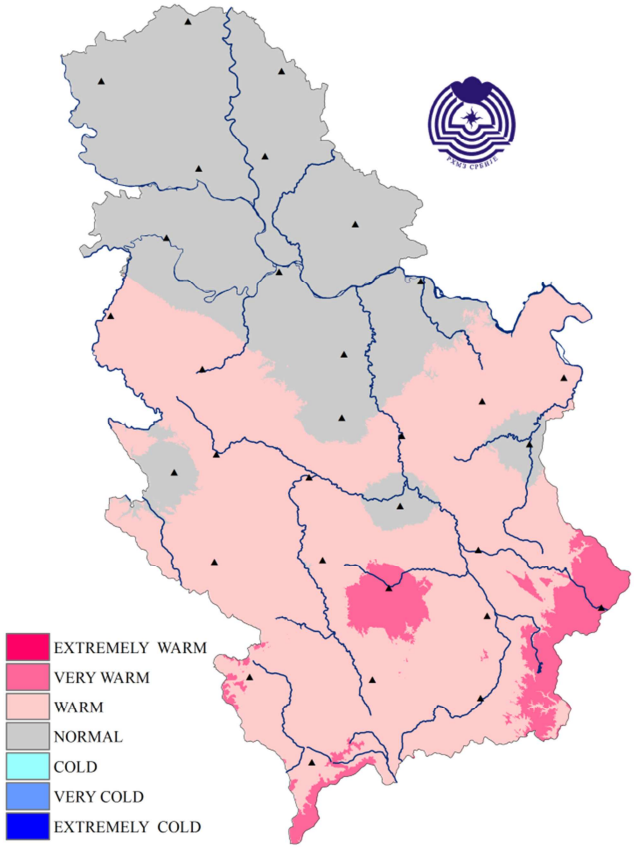


Figure 3. Air temperature assessment in Serbia during summer using percentile method compared to the 1981-2010 base period

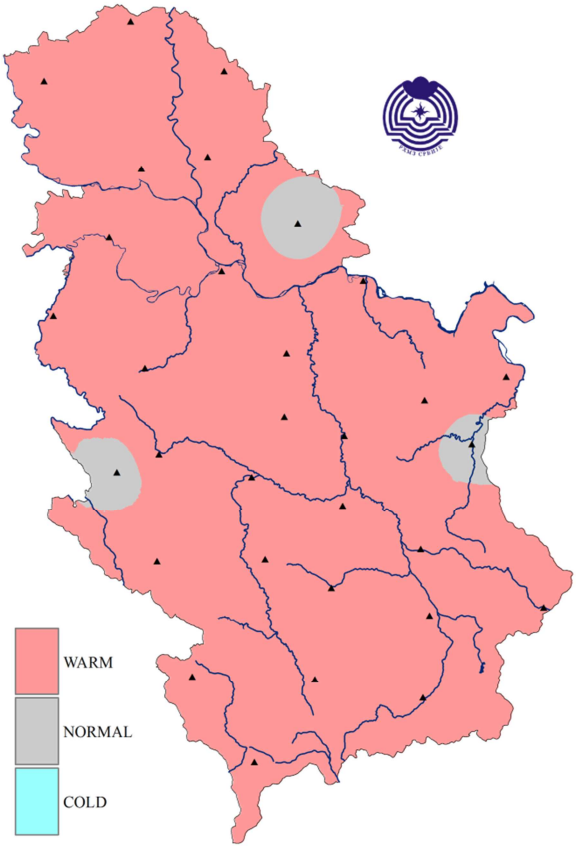


Figure 4. Air temperature assessment in Serbia during summer using tercile method compared to the 1981-2010 base period

The highest daily air temperature during summer, measuring 38°C was registered in Nis on July 14.

The number of summer days, with the maximum daily air temperature exceeding 25°C, ranged from 66 days in Pozega and Kursumlija to 83 days in Zajecar. As for high-lying areas, the highest number of summer days was recorded in Sjenica, total of 39 days, whilst Kopaonik didnt observe any summer days. Belgrade observed 76 summer days, which is 8 days above the average. Most of Serbia experienced more summer days in comparison with the average for the 1981-2010 period, apart from Crni Vrh and Kopaonik where 4 days that is 2 days below the average were recorded, respectively. The highest positive deviation from the number of

[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

summer days from the average was registered in Sombor and Valjevo, total of 11 days (*Figure* 5).

The number of tropical days, with the maximum daily air temperature exceeding 30°C, ranged from 24 days on Palic, Novi Sad, Loznica, Valjevo, Pozega up to 48 days in Negotin. As for the high-lying areas, one tropical day was recorded on Zlatibor and two days in Sjenica. Belgrade observed 33 tropical days. Central, eastern and southern parts of Serbia observed more tropical days in comparison with the average for the 1981-2010 period, whereas fewer tropical days were recorded in northern and western regions. The highest positive deviation of number of tropical days from the average was recorded in Dimitrovgrad, total of 11 days, whilst Loznica observed 6 days below the average (*Figure* 6).

Most of Serbia experienced tropical nights with the minimum daily air temperature exceeding 20°C. Dimitrovgrad didnt observe any, neither did the mountains, apart from Crni Vrh where one tropical night was registered. The highest number of tropical nights was observed in Belgrade, total of 23, and the highest deviation, 10 days above the average, was registered in Negotin.

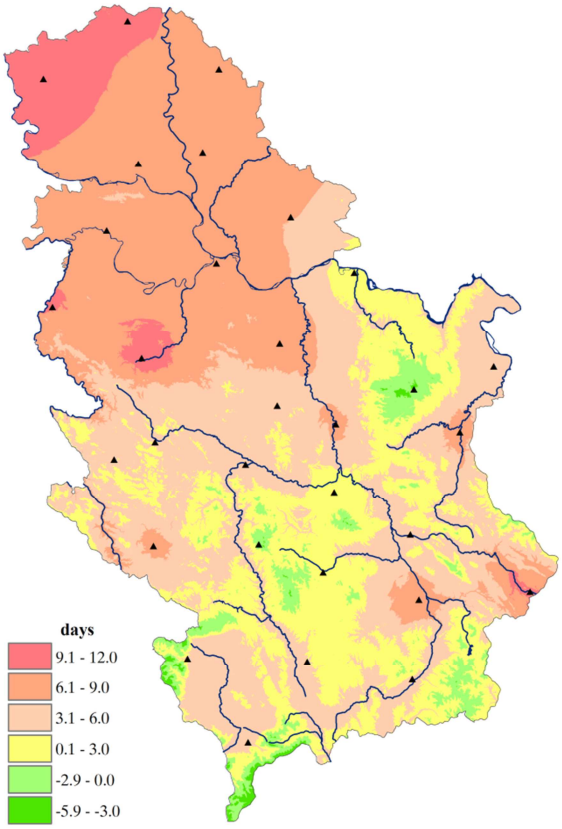


Figure 5. Deviation of the number of summer days compared to the normal 1981-2010

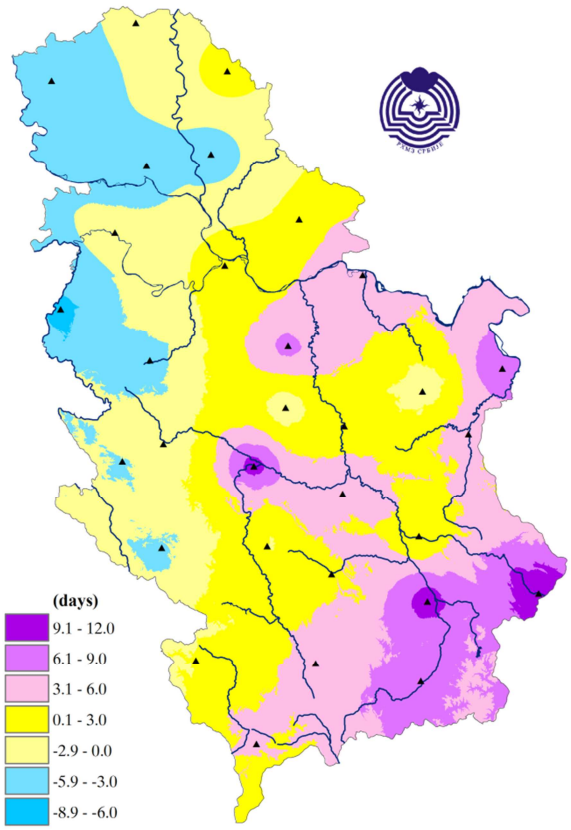


Figure 6. Deviation of the number of tropical days during summer compared to the normal 1981-2010

The lowest summer air temperature of 2.8°C, was measured at Kopaonik on August 13.

Most of the summer period, mean, maximum and minimum air temperature was within the multiannual average. Warm periods followed by abrupt changes to cooler periods took place at the beginning of the second half and in the middle of the third decade of June, as well as the beginning of the second decade of June. Cooler periods were observed at the beginning of the second and third decade of August (*Figure* 7).

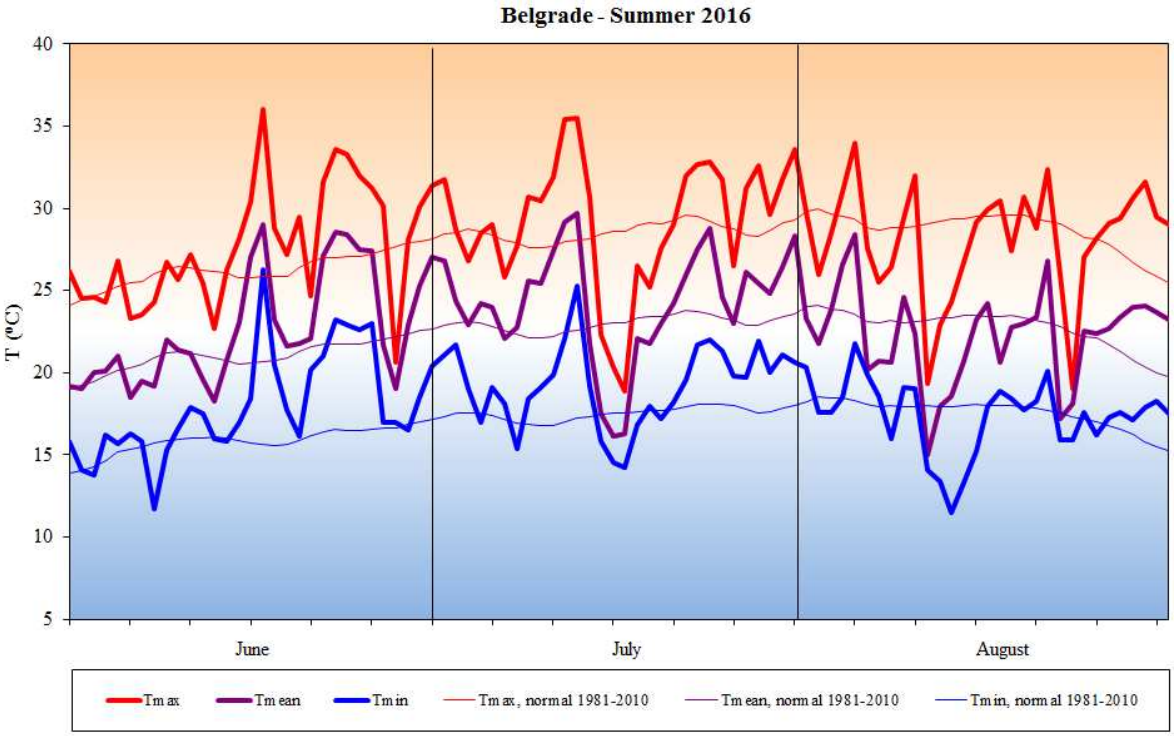


Figure 7. Three-month course of the mean, maximum and minimum air temperature in Belgrade

Three month-course of the mean daily air temperature in Belgrade, Kopaonik and Zajecar in summer 2016 is shown in Figures 8, 9 and 10.

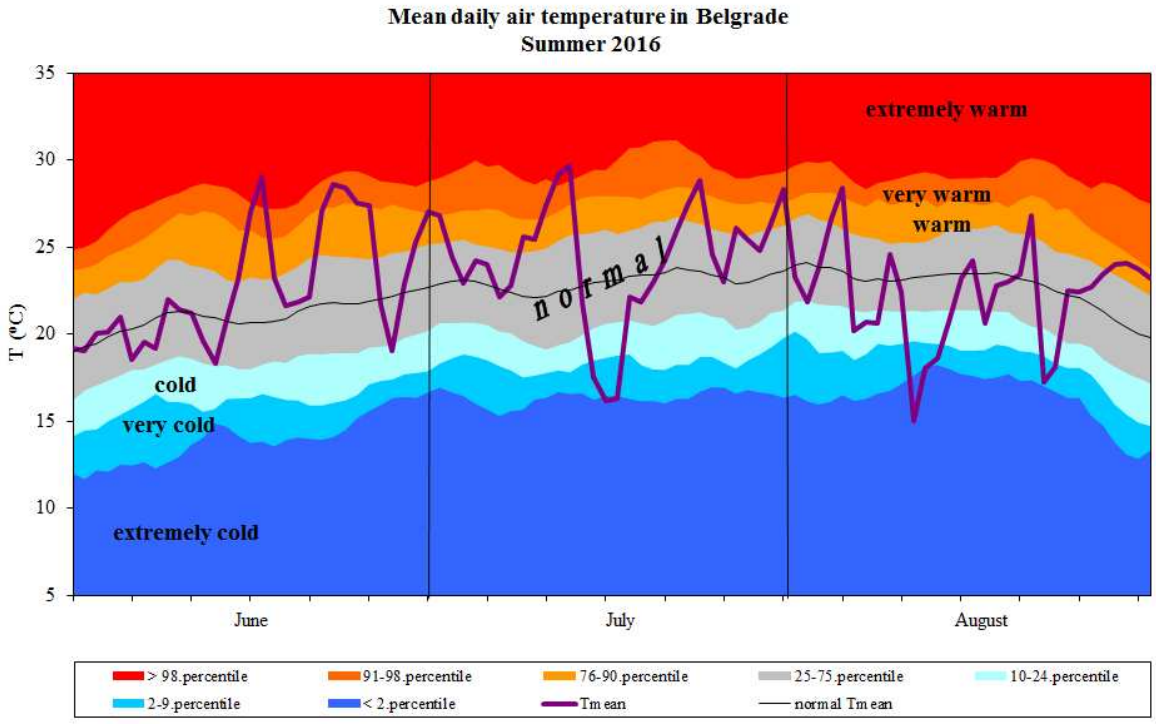


Figure 8. Three-month course of the mean daily air temperature in Belgrade

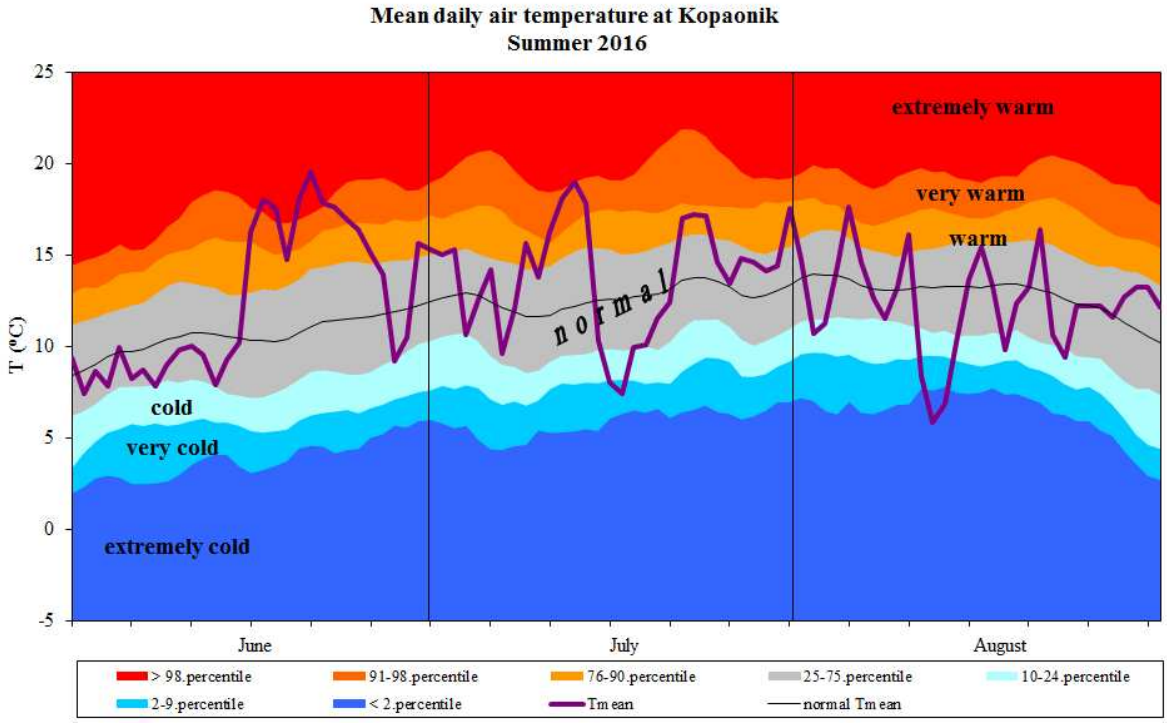


Figure 9. Three-month course of the mean daily air temperature at Kopaonik

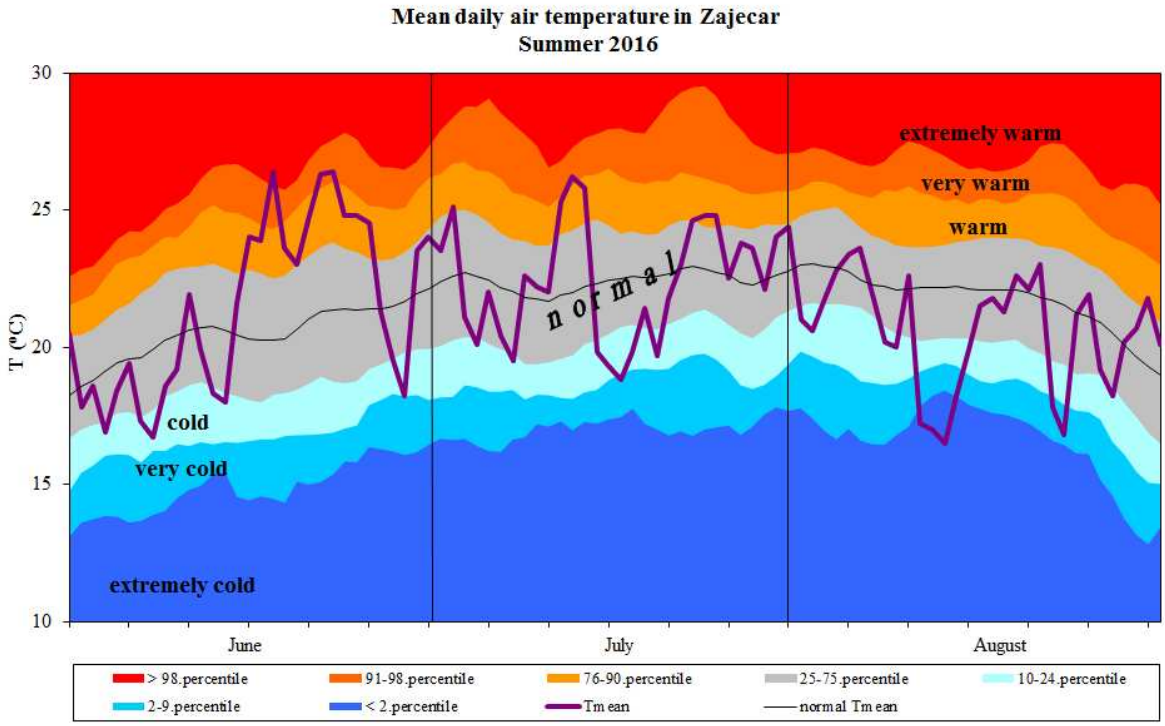


Figure 10. Three-month course of the mean daily air temperature in Zajecar

During summer 2016, only one heat wave was registered in in the period from 17 to 25 June in Vranje and Dimitrovgrad.

Precipitation

Summer precipitation sums were within the average across most of Serbia compared to the normal for the 1981-2010 base period. Seasonal precipitation sums were below the average in Kraljevo, and above the average in northern, western and southern Serbia. Compared to the normal, precipitation sums ranged from 60% in Kraljevo to 177% in Zrenjanin (*Figure* 11).

Based on the percentile method, summer precipitation sums were in the normal and rainy category across most of Serbia, very rainy in Zrenjanin, Sjenica and Zlatibor, and sunny category in Kraljevo (*Figure* 12).

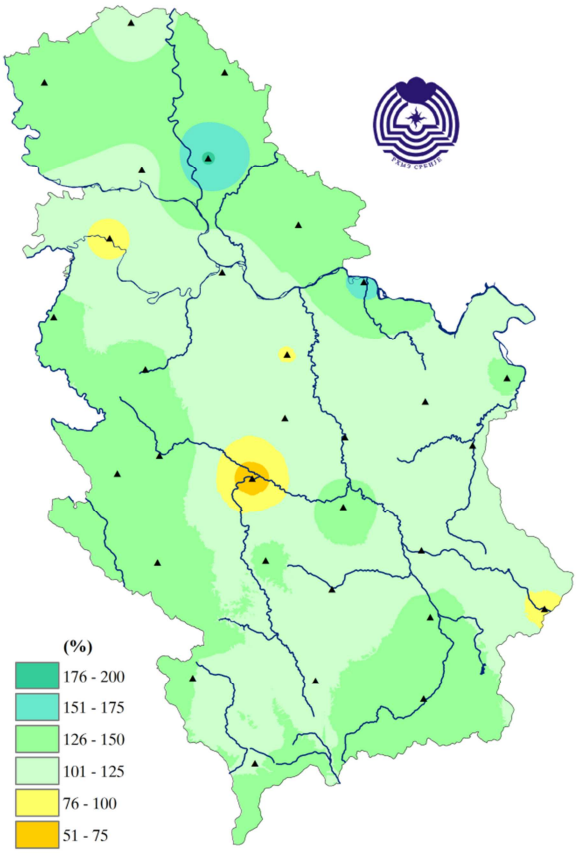


Figure 11. Spatial distribution of the precipitation sums expressed in the percentages of normal 1981-2010 during summer

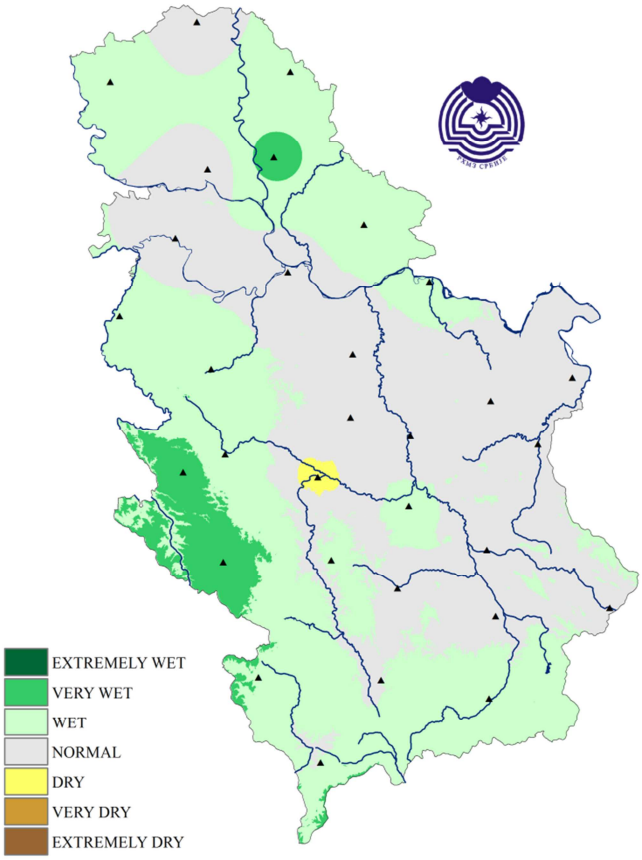


Figure 12. Precipitation sums assessment using percentile method during summer compared to the 1981-2010 base period

Based on the tercile method, precipitation sums were above the average in most of Serbia (*Figure* 13).

The maximum daily precipitation total of 137.1 mm was recorded in Negotin on July 16.

The highest negative departure of the number of days with precipitation of 1 mm and above was observed in Zajecar, 6 days below the average for summer, whilst Kikinda observed 5 days above the average (*Figure* 14).

Summer of 2016 was the third wettest on record in Zrenjanin, in the period from 1925 to 2016 (*Figure* 15).

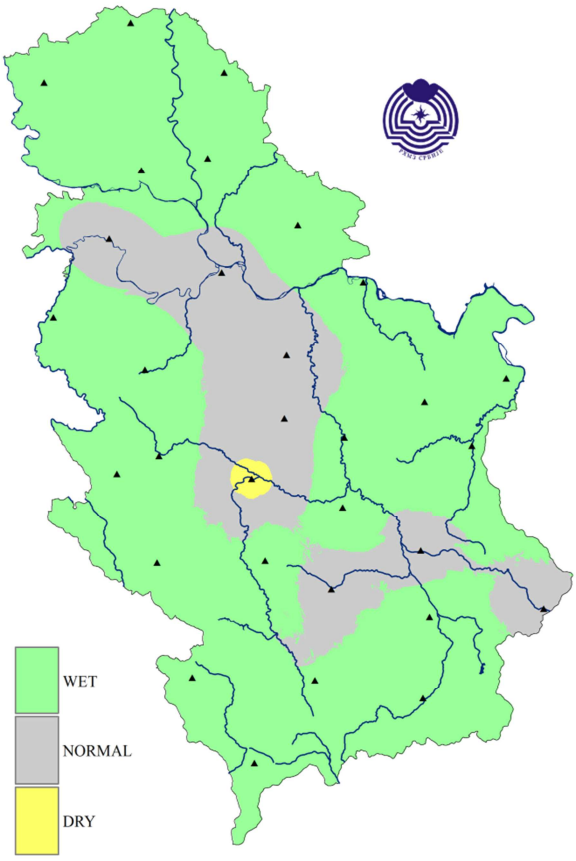


Figure 13. Precipitation sums assessment using tercile method during summer compared to the 1981-2010 base period

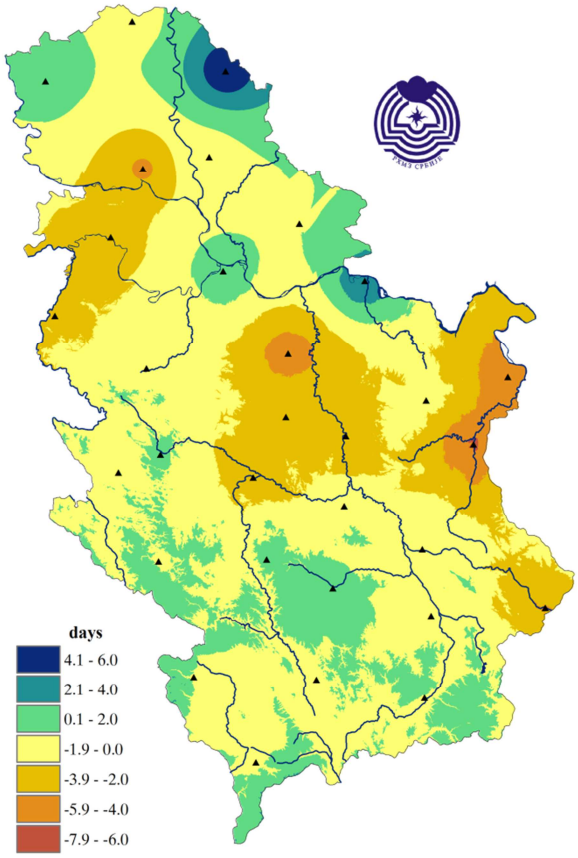


Figure 14. Deviation of the number of days with precipitation from 1mm and above during summer

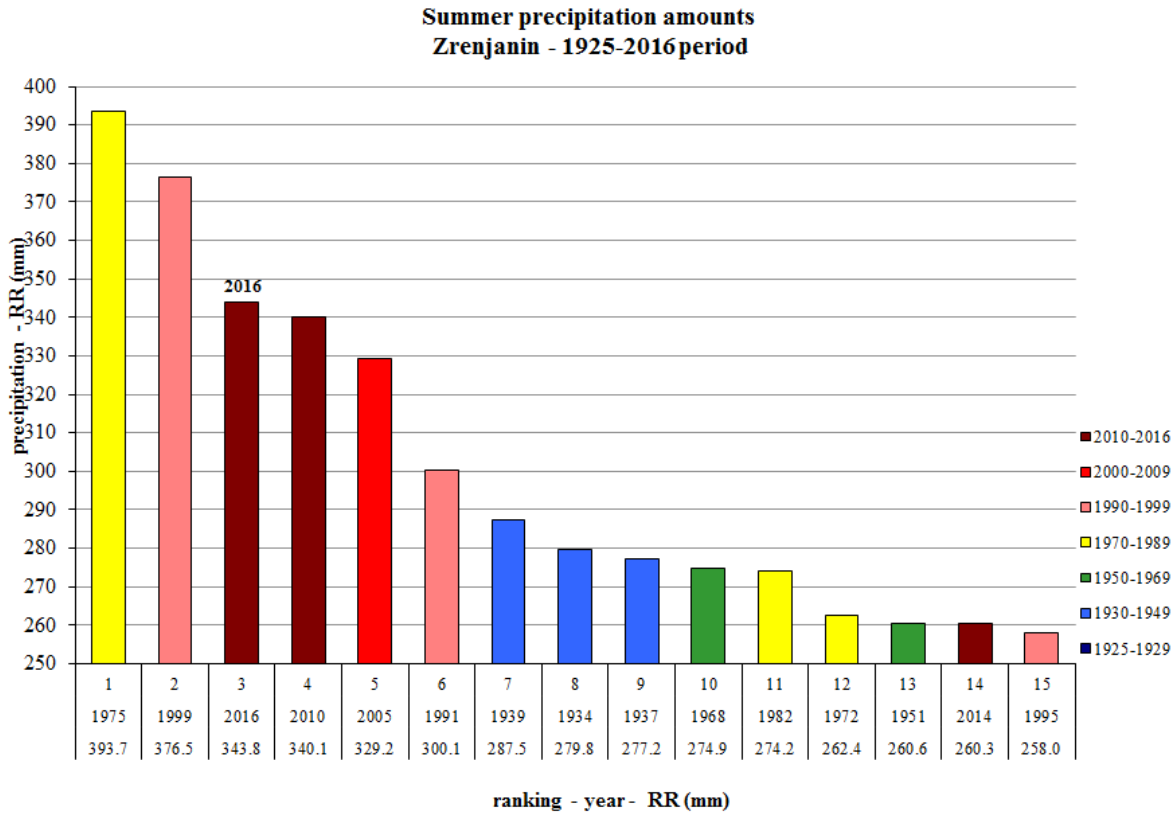


Figure 15. Ranking of the top 15 wettest months of Summer for Zrenjanin for the period 1925-2016

Figures 16 and 17 show summer cumulative precipitation sums per month compared to the average cumulative precipitation sums for Belgrade, Kraljevo and Zlatibor.

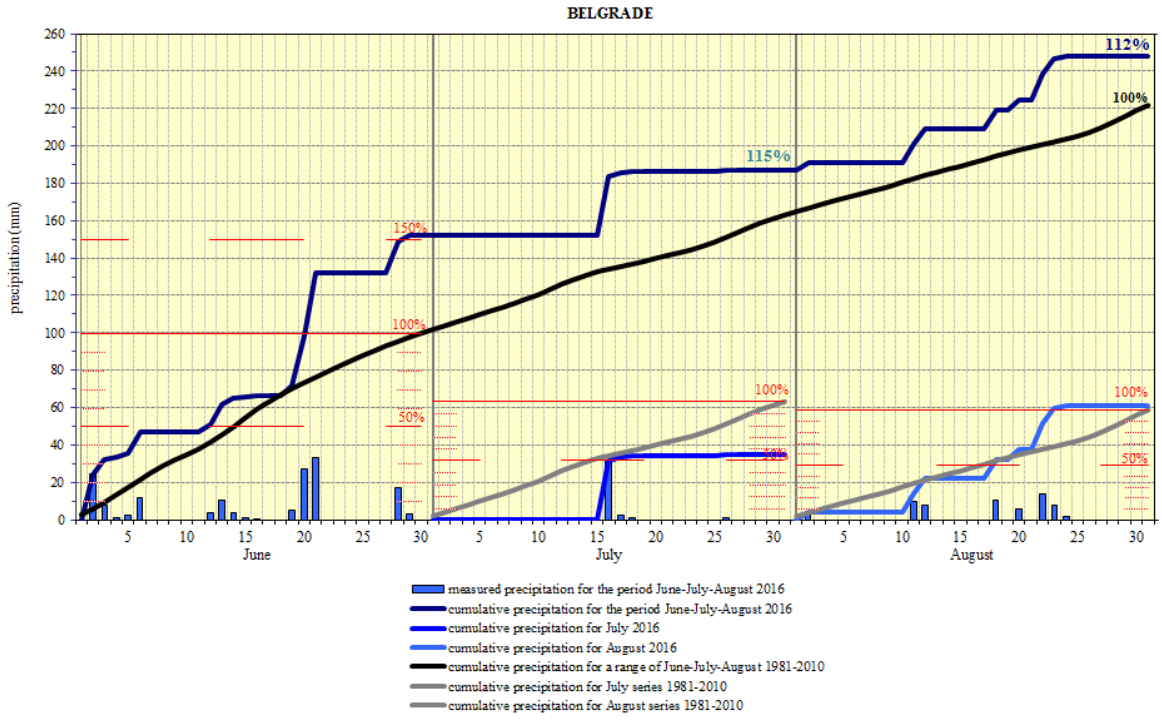


Figure 16. Cumulative precipitation sums in Belgrade

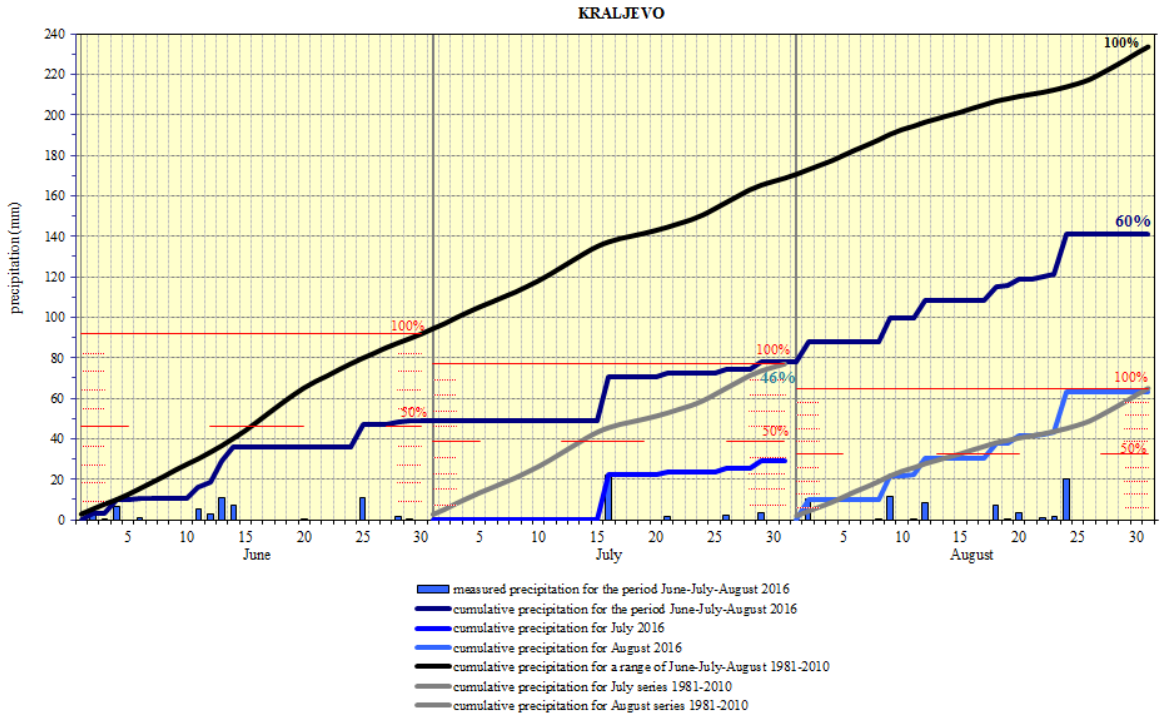


Figure 17. Cumulative precipitation sums in Kraljevo

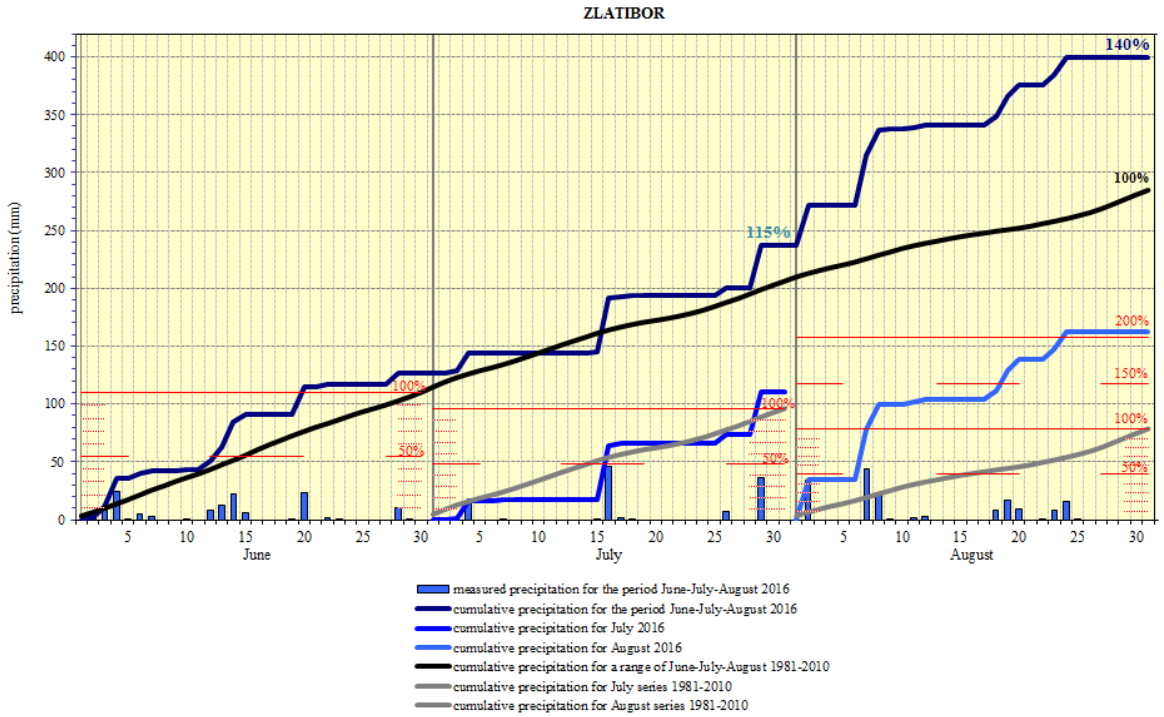


Figure 18. Cumulative precipitation sums at Zlatibor

Sunshine duration (insolation)

Sunshine duration in summer 2016 was within the average in most of Serbia. Insolation ranged from 630.6 in Sjenica to 902.6 hours in Negotin (*Figure 19).*

Compared to the normal for the 1981-2010 base period, sunshine duration ranged from 86% in Sjenica to 107% in Zrenjanin and Krusevac (*Figure 20*).

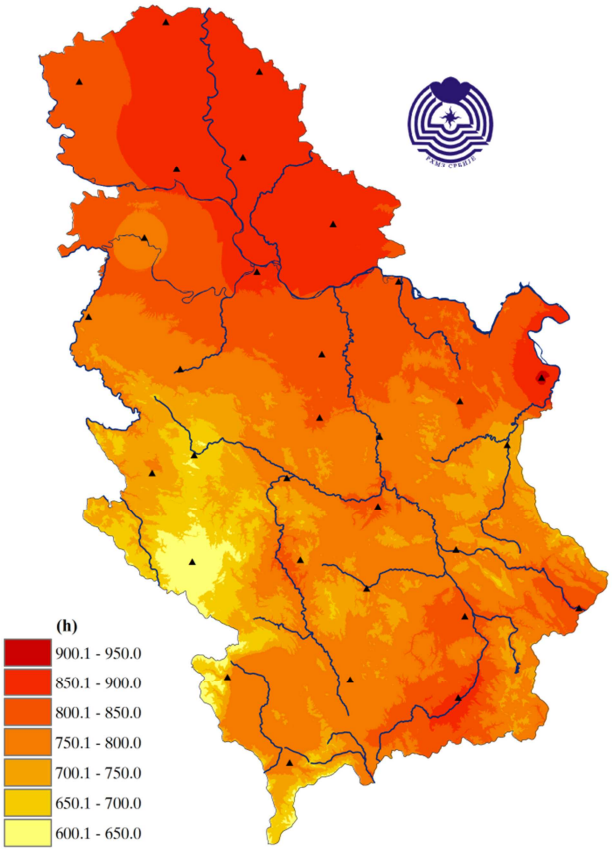


Figure 19. Insolation expressed in hours during summer

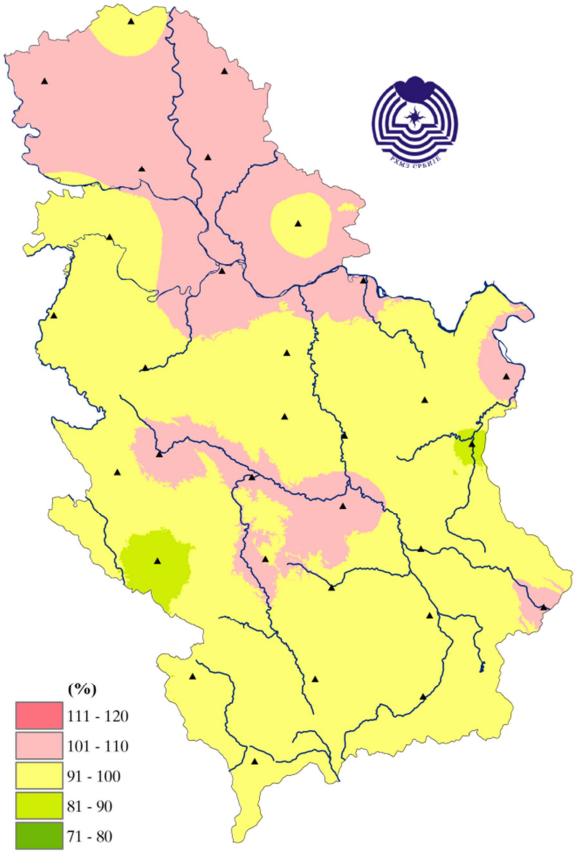


Figure 20**.** Insolation expressed in the percentages of normal during summer

Analysis of the 2016 summer season for Serbia compared to the 1961-1990 base period

Temperature

Departure of the mean air temperature from the normal, in summer, for the 1961-1990 base period ranged from 1,3ºC in Zajecar to 2,4ºC in Negotin, and on the mountains from 1,5°C on Zlatibor to 2,2°C at Kopaonik (*Figure 21*).

Based on the percentile method, mean air temperature was in the category of extremely and very warm across the entire country (*Figure* 22).

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

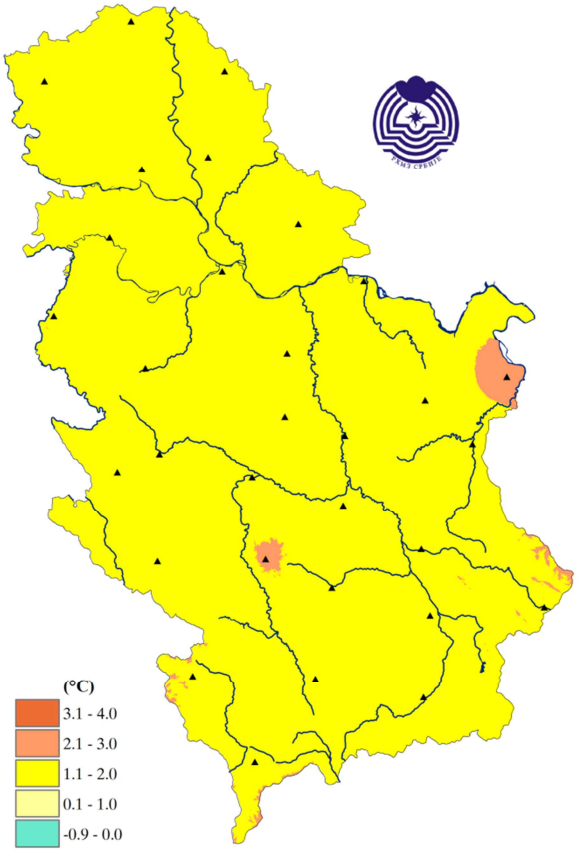


Figure 21. Seasonal mean air temperature anomaly compared to the 1961-1990 base period

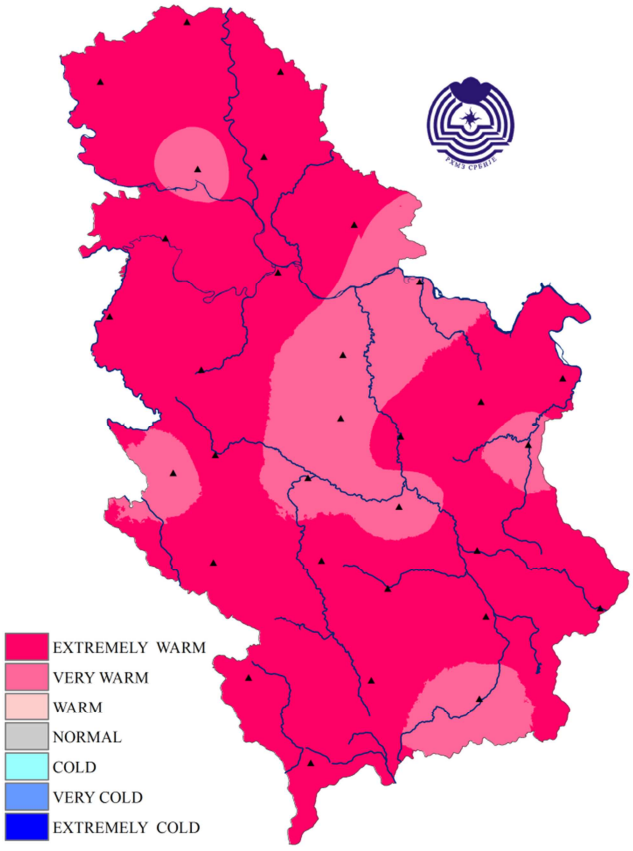


Figure 22. Assessment of the air temperature in Serbia using percentile method compared to the 1961-1990 base period

Precipitation

Summer precipitation sums were above and within the average across most of the country compared to the normal for the 1961-1990 base period, apart from Kraljevo where the observed seasonal precipitation sums were below the average. Precipitation sums compared to the normal ranged from 62% in Kraljevo to 185% in Zrenjanin (*Figure* 23).

Based on the percentile method, summer precipitation sums were in the categories of normal and rainy across most of Serbia, very rainy in Sombor, Pozega and Zlatibor, extremely rainy category in Zrenjanin, and very dry category in Kraljevo only (*Figure* 24).

Based on the tercile method, precipitation sums were above and within the average across most of Serbia, only in Kraljevo precipitation sums were below the average.

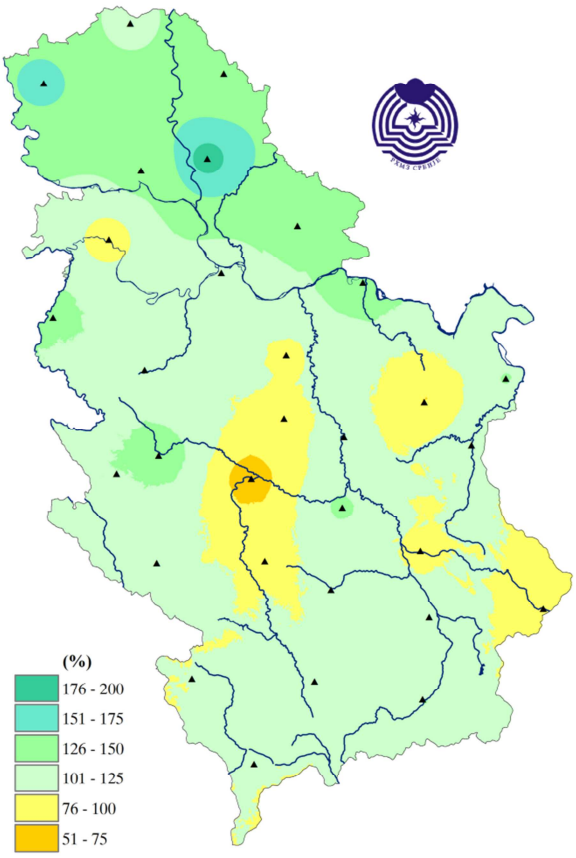


Figure 23. Spatial distribution of precipitation sums expressed in the percentages of normal compared to the 1961-1990 base period

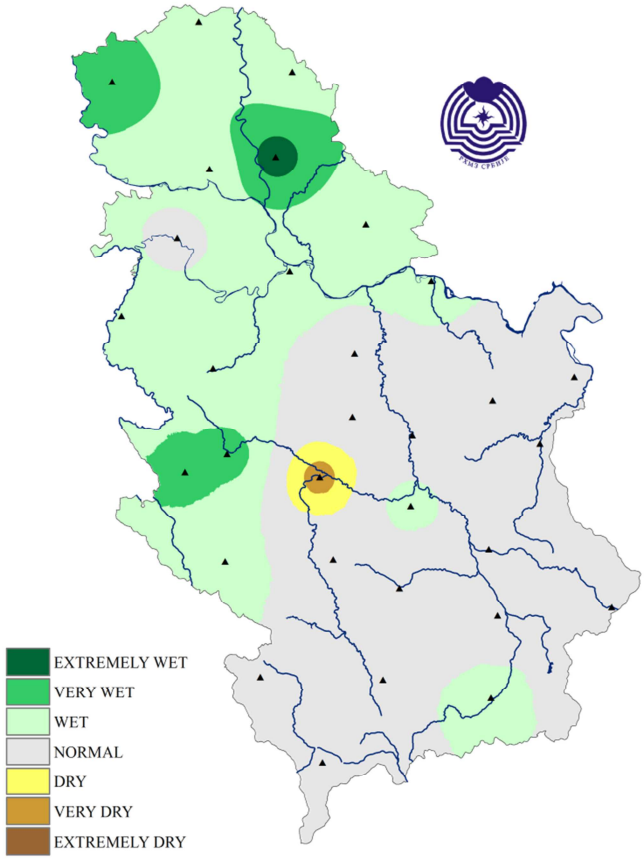
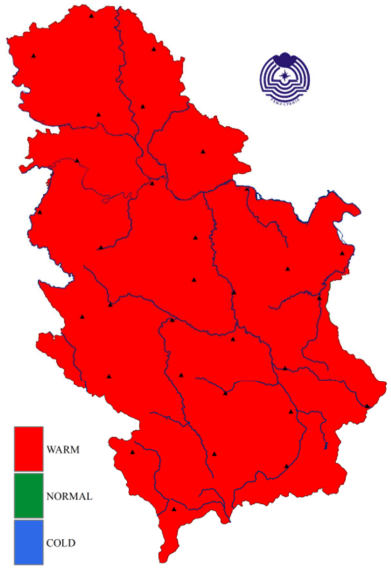
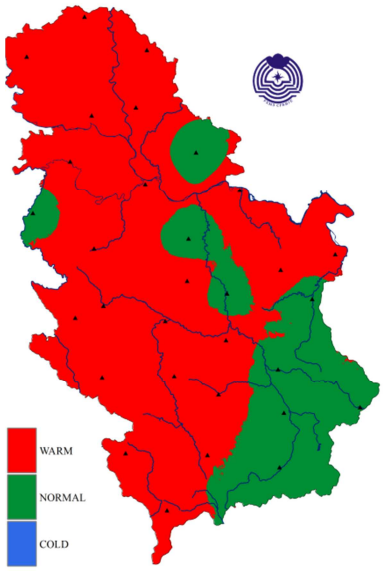


Figure 24. Assessment of the precipitation sums using percentile method compared to the 1961-1900 base period

Monitoring of air temperature for the summer seasons for years from 2008 to 2016 in Serbia using tercile method, compared to the 1981-2010 base period



2008



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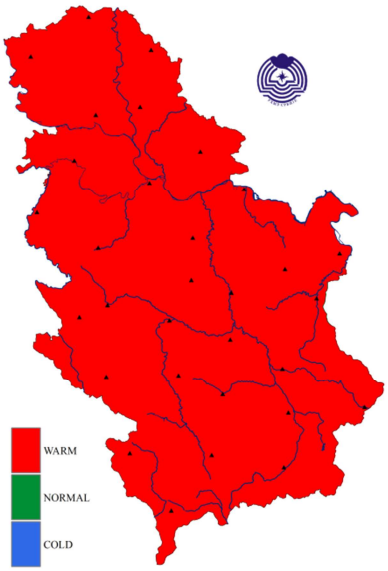

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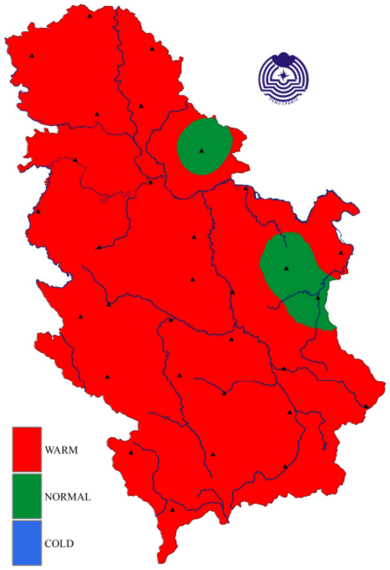

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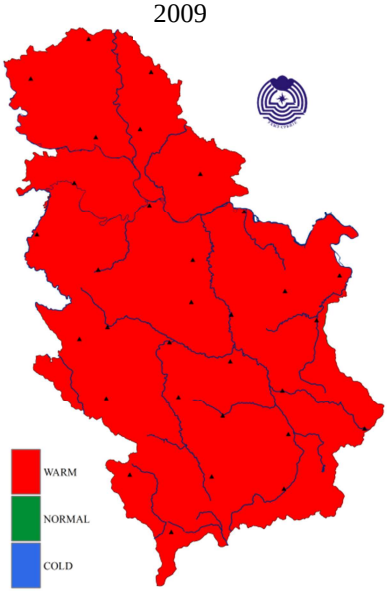

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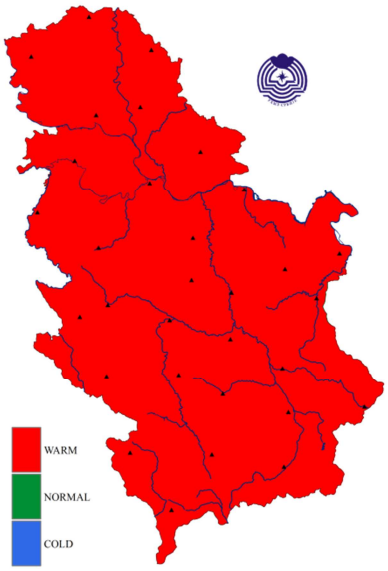

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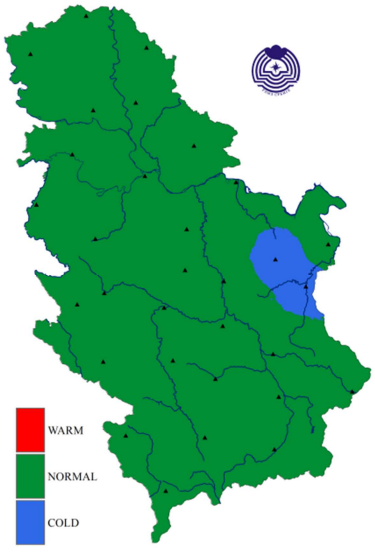

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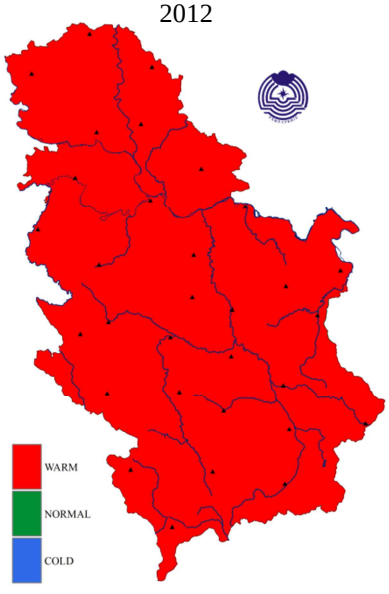

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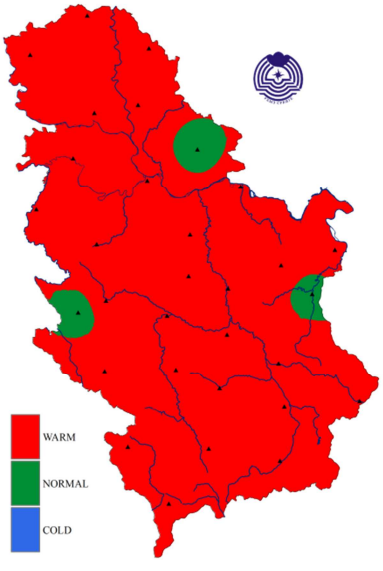
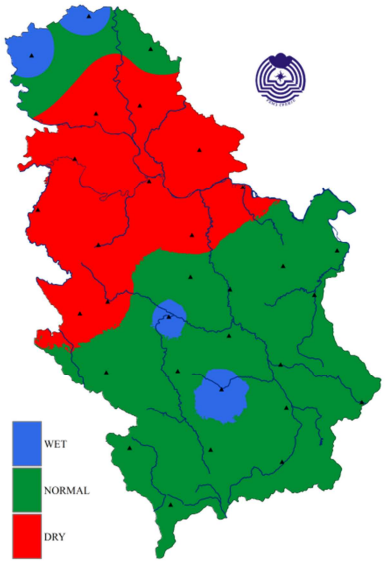


2016

Monitoring of precipitation for the summer seasons for years from 2008 to 2016 in Serbia using tercile method, compared to the 1981-2010 base period



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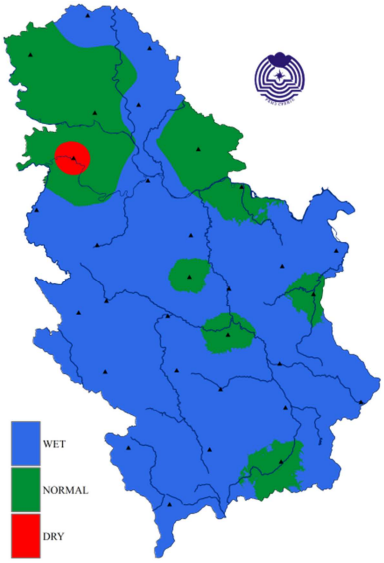

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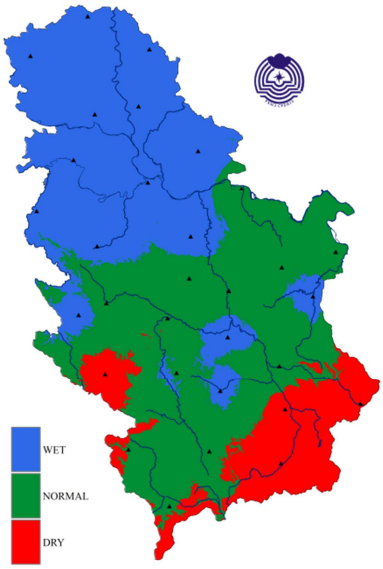

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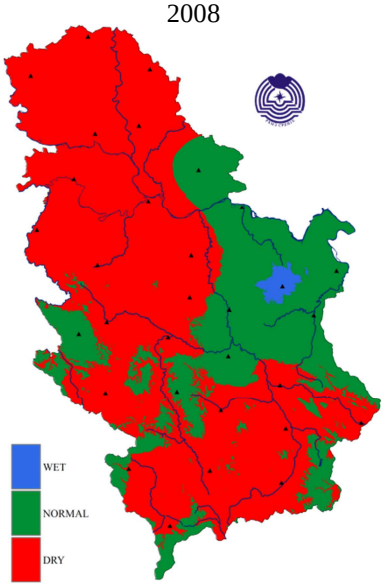

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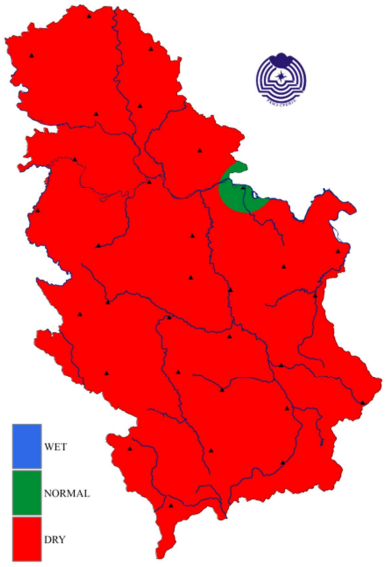

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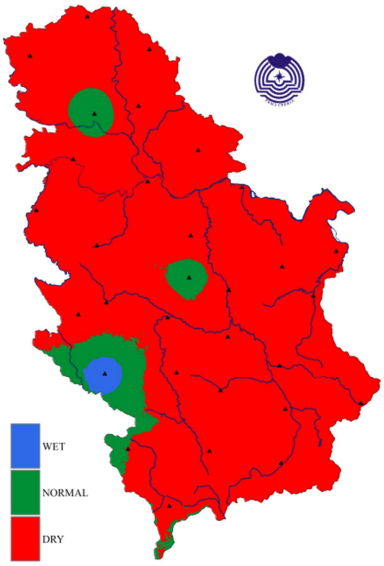

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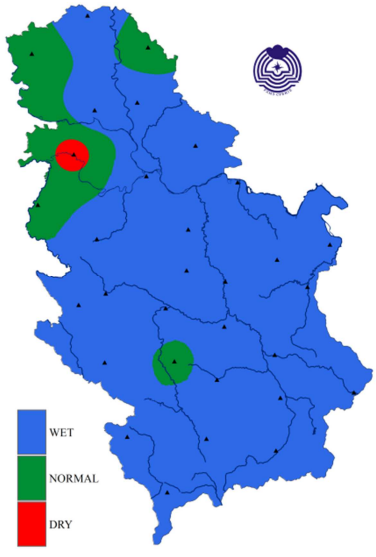

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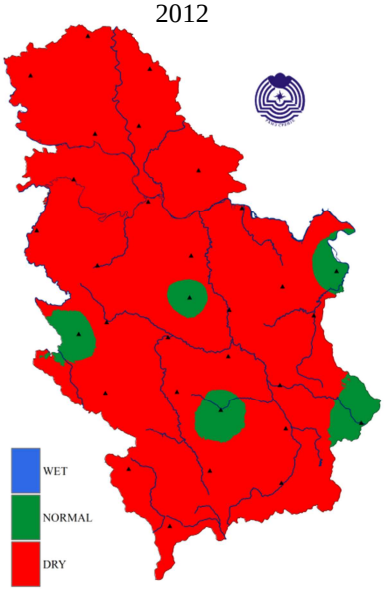

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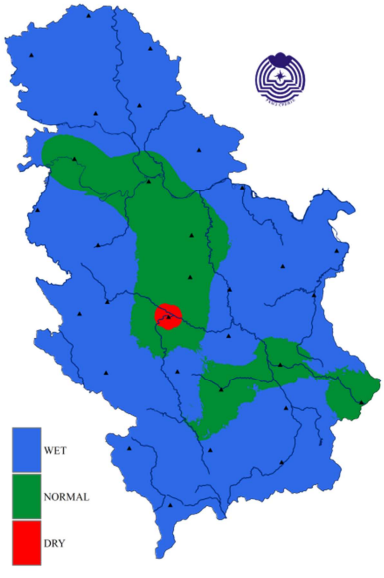

2016