VERIFICATION OF THE SEECOF–18 WINTER 2017/2018 CLIMATE OUTLOOK AND SEASONAL BULLETIN FOR THE TERRITORY OF SERBIA

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Temperature

According to the SEECOF-18 outlook for the winter 2017/2018 in Serbia, warmer than normal temperature in Serbia was indicated, compared to the 1981–2010 climatological base period (*Figure* A) with around +1^{o}C seasonal temperature anomaly.
Climatological monitoring showed that the winter 2017/2018 was warm in almost entire Serbia, except the Mount Kopaonik region, with above-normal temperature based on the tercile method (*Figure* B). The outlook for a warm winter was correct, with exception of Mount Kopaonik region where normal winter was indicated with the 30% probability.

OUTLOOK – WINTER **2017/2018**

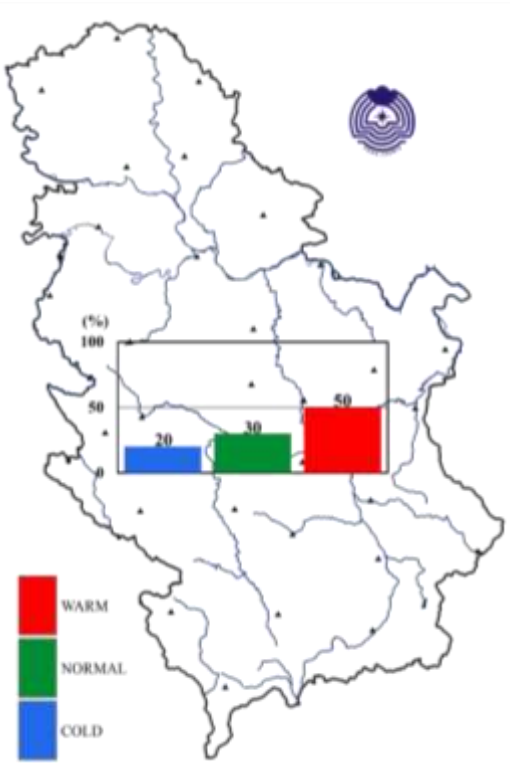


Figure A. SEECOF-18 - winter temperature outlook

MONITORING – WINTER **2017/2018**

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

Precipitation

The SEECOF–18 climate outlook for the winter 2017/2018 in Serbia indicated approximately equal probabilities for below, near and above-average conditions (*Figure* C) As a consequence average seasonal precipitation sum were expected.
Monitoring of precipitation showed wet winter conditions in most of Serbia, except in north-eastern part (*Figure* D).

OUTLOOK – WINTER **2017/2018**

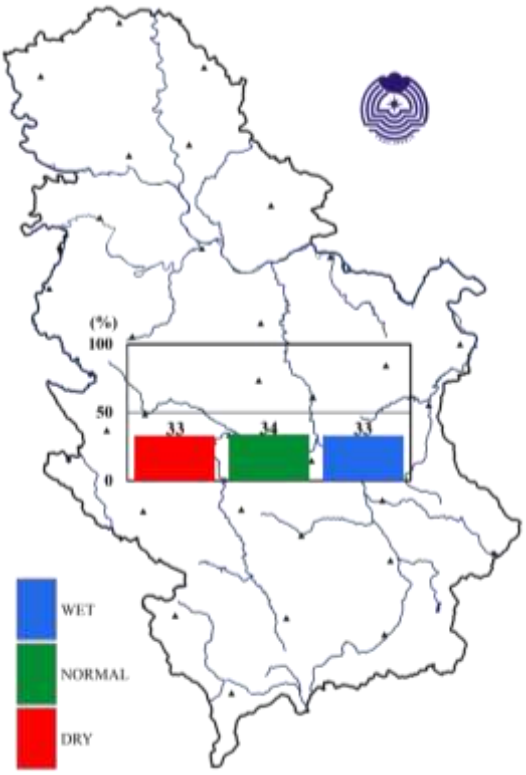


Figure C. SEECOF-18 - winter precipitation outlook

MONITORING – WINTER **2017/2018**

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

Winter 2017/2018			Air Temperature (°C)			
Station	Rank*	Rank**	33	50	66	Observed value
Beograd (1888-2017)	12	7	1.5	2.4	3.0	4.2
Palić (1945-2017)	12	9	-0.1	0.5	1.5	2.4
Sombor (1942-2017)	14	11	0.0	0.9	1.8	2.5
Novi Sad (1948-2017)	9	7	0.4	1.1	1.8	3.1
Zrenjanin (1946-2017)	11	8	0.3	1.0	1.8	3.0
Kikinda (1948-2017)	10	8	0.1	0.9	1.7	2.7
Banatski Karlovac (1986-2017)	7	7	0.7	1.4	2.0	3.1
Loznica (1952-2017)	7	6	0.7	1.8	2.5	4.0
Sremska Mitrovica (1925-2017)	17	9	0.4	0.9	1.6	2.6
Valjevo (1926-2017)	12	7	0.7	1.3	2.2	3.4
Kragujevac (1925-2017)	14	9	0.9	1.5	2.3	3.3
Smederevska Palanka (1939-2017)	12	8	0.7	1.5	2.1	3.3
Veliko Gradište (1926-2017)	14	8	0.4	1.0	1.6	2.7
Crni Vrh (1967-2017)	11	10	-3.6	-3.2	-2.1	-1.7
Negotin (1927-2017)	10	8	0.7	1.1	1.8	2.6
Zlatibor (1950-2017)	14	10	-2.2	-1.8	-0.8	-0.4
Sjenica (1946-2017)	11	9	-3.4	-2.5	-2.0	-1.1
Pozega (1952-2017)	9	7	-1.3	-0.7	0.3	1.2
Kraljevo (1926-2017)	13	8	0.5	1.1	2.1	2.9
Kopaonik (1950-2017)	18	15	-5.0	-4.6	-3.8	-3.9
Kursumlija (1952-2017)	9	7	0.3	1.0	1.5	2.7
Krusevac (1927-2017)	14	9	0.7	1.1	1.9	2.8

Cuprija (1948-2017)	12	8	0.4	1.2	1.7	2.9
Nis (1925-2017)	12	8	1.1	1.6	2.3	3.5
Leskovac (1948-2017)	11	8	0.3	0.9	1.7	2.9
Zajecar (1929-2017)	12	10	0.0	0.4	1.1	1.9
Dimitrovgrad (1945-2017)	14	8	-0.5	0.0	1.1	1.8
Vranje (1926-2017)	18	9	0.3	1.0	1.7	2.4

*Rank –period of stations work (warmest season)
**Rank – 1981-2018 period (warmest season)

Winter 2017/2018			Precipitation sums (mm)			
Station	Rank*	Rank**	33	50	66	Observed Value
Beograd (1888-2017)	60	22	129.8	152.3	158.3	142.6
Palić (1945-2017)	3	2	90.1	104.4	121.5	186.5
Sombor (1942-2017)	13	5	104.2	114.8	123.0	167.8
Novi Sad (1948-2017)	10	3	109.9	119.1	133.5	177.9
Zrenjanin (1946-2017)	13	3	106.5	115.7	127.0	169.2
Kikinda (1948-2017)	9	4	98.0	105.5	121.2	169.9
Banatski Karlovac (1946-2017)	38	20	108.3	122.7	132.5	124.2
Loznica (1926-2017)	8	4	166.4	171.6	201.4	249.4
Sremska Mitrovica (1925-2017)	15	2	103.0	115.9	130.1	174.7
Valjevo (1926-2017)	15	8	149.5	157.6	173.3	196.0
Kragujevac (1925-2017)	18	8	113.0	120.0	134.0	169.0
Smederevska Palanka (1939-2017)	30	15	121.8	132.7	157.6	153.9
Veliko Gradište (1926-2017)	43	21	120.8	147.9	161.3	143.0

Crni Vrh (1967-2017)	13	12	127.6	143.8	170.7	182.2
Negotin (1927-2016)	10	7	105.9	137.3	186.9	248.1
Zlatibor (1950-2017)	6	5	204.3	225.1	237.8	285.2
Sjenica (1946-2017)	3	2	140.9	151.4	177.6	250.4
Pozega (1952-2017)	14	6	124.3	147.5	157.6	194.0
Kraljevo (1926-2017)	22	11	126.9	137.3	156.8	187.5
Kopaonik (1950-2017)	12	11	158.1	204.0	232.1	256.6
Kursumlija (1952-2017)	2	1	123.5	150.9	174.5	282.1
Krusevac (1927-2017)	9	7	115.1	133.2	155.6	200.3
Cuprija (1948-2017)	7	5	127.5	148.1	163.1	217.6
Nis (1925-2017)	2	1	117.7	137.1	150.6	249.9
Leskovac (1948-2017)	3	1	127.3	150.4	161.8	243.4
Zajecar (1929-2017)	4	3	103.7	136.3	146.6	243.7
Dimitrovgrad (1945-2017)	4	1	111.6	120.4	143.9	237.2
Vranje (1926-2017)	2	1	111.7	126.9	137.1	246.2

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

**Rank – 1981-2018 period (highest seasonal precipitation)

Country	Seasonal temperature DJF		Seasonal precipitation DJF		High Impact Events
	Observed	SEECOF-18 climate outlook for temperature	Observed	SEECOF-18 climate outlook for precipitation	
Serbia (1)	Above normal in almost entire Serbia	**Above-normal** (20, 30, 50) in entire Serbia	Above normal in most of Serbia, except in north-eastern part	**No predictive signal** (33, 34, 33) in entire Serbia	* **Winter of 2017/2018** was the 4th wettest and 12th warmest for Serbia * **December** was wettest in Leskovac (southern Serbia), record breaking daily precipitation sum in Kursumlija and Dimitrovgrad; 4th warmest in Loznica, two heat waves; * **January** was the 5th warmest for Serbia**,** 2nd warmest in Sombor and Banatski Karlovac; * **February** was 9th wettest in Serbia, at Palic 3rd, at Sjenica and Zlatibor 4th wettest

Winter of 2017/18 ranks as the 12th warmest for Serbia, and the 7th warmest for Loznica and Banatski Karlovac.The cold wave was registered at the end of Febraury. The 4th wettest winter for Serbia. Seasonal forecast for winter was exceptionally good in terms of air temperature, the number of frost and ice days, as well as the total seasonal precipitation sums in northern and central parts.

Analysis of the winter 2017/2018 for Serbia relative to the 1981-2010 base period

Temperature

The seasonal air temperature in winter ranged from 1.2ºC in Pozega to 4.2ºC in Belgrade, and on the mountains from -3.9ºC at Kopaonik to -0.4ºC at Zlatibor (Figure 1).

Departure of the mean air temperature from the normal[1], in winter ranged from 1.3ºC in Zajecar to 2.1ºC in Loznica, and on the mountains from 0.5ºC at Kopaonik to 1.7ºC in Sjenica (Figure 2).

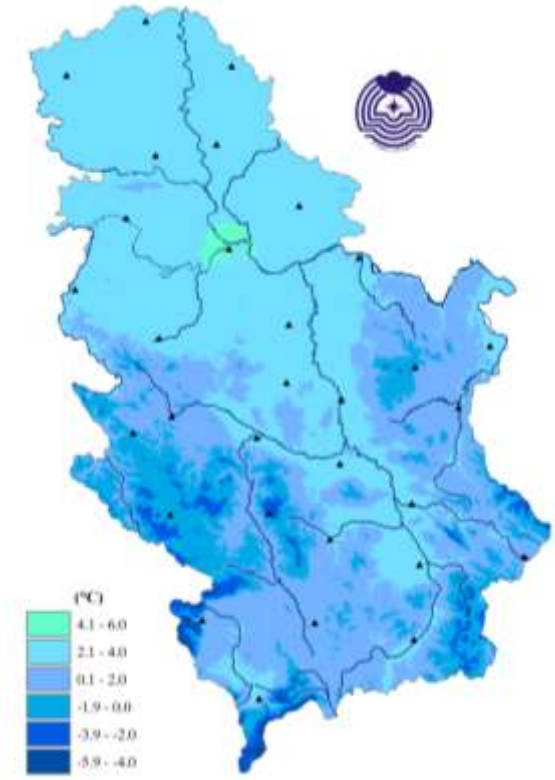


Figure 1. Mean seasonal air temperature

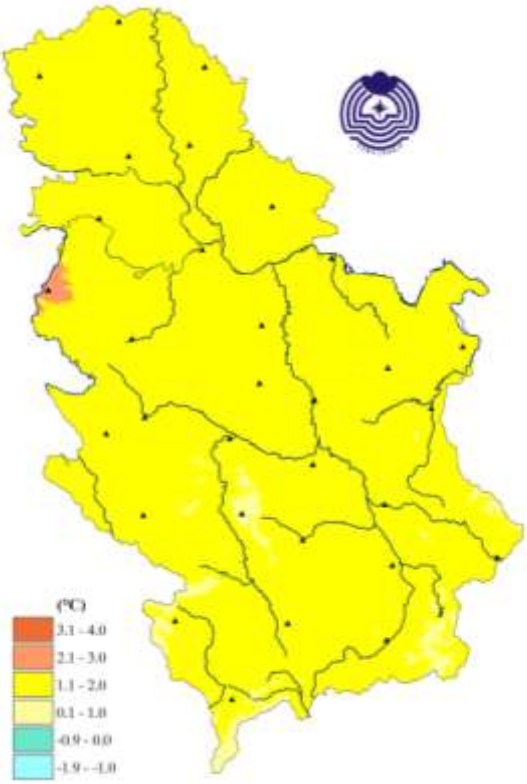
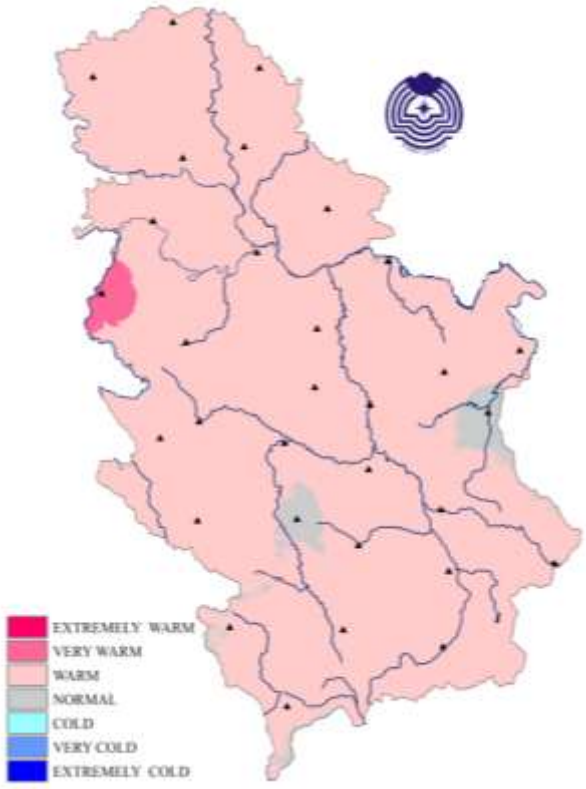


Figure 2. Departure of the mean seasonal air temperature relative to the 1981-2010 base period

[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 air temperature in winter was in the following categories: warm in most of Serbia, very warm in Loznica, and normal category in Zajecar and Kopaonik (Figure 3).

Based on the tercile method, the mean winter air temperature was in the warm category in the entire country apart from Kopaonik where it was in the normal category (Figure 4).



Slika 3. Mean seasonal air temperature based on percentile method

Figure 4. Mean seasonal air temperature based on tercile method

[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

Winter of 2017/2018 was the **12th warmest** winter for Serbia (Figure 5), and **7th warmest** for Loznica (Figure 6) and Banatski Karlovac.

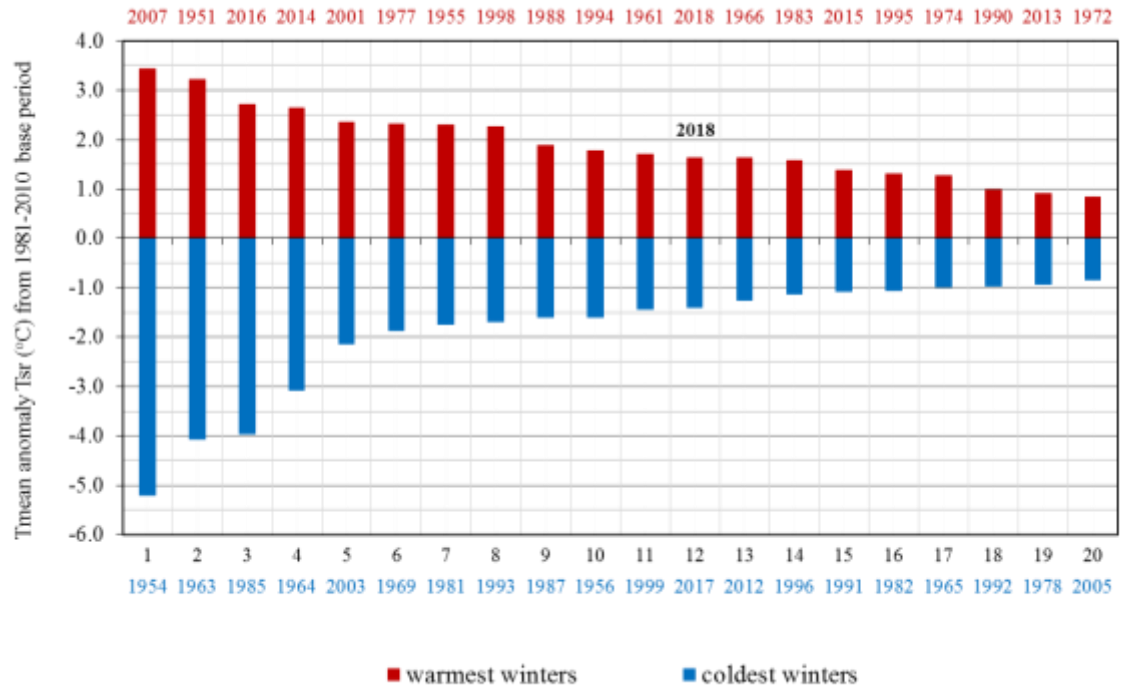


Figure 5. Rank of the wearmest and coldest winter seasons in Serbia for the 1951-2018 period

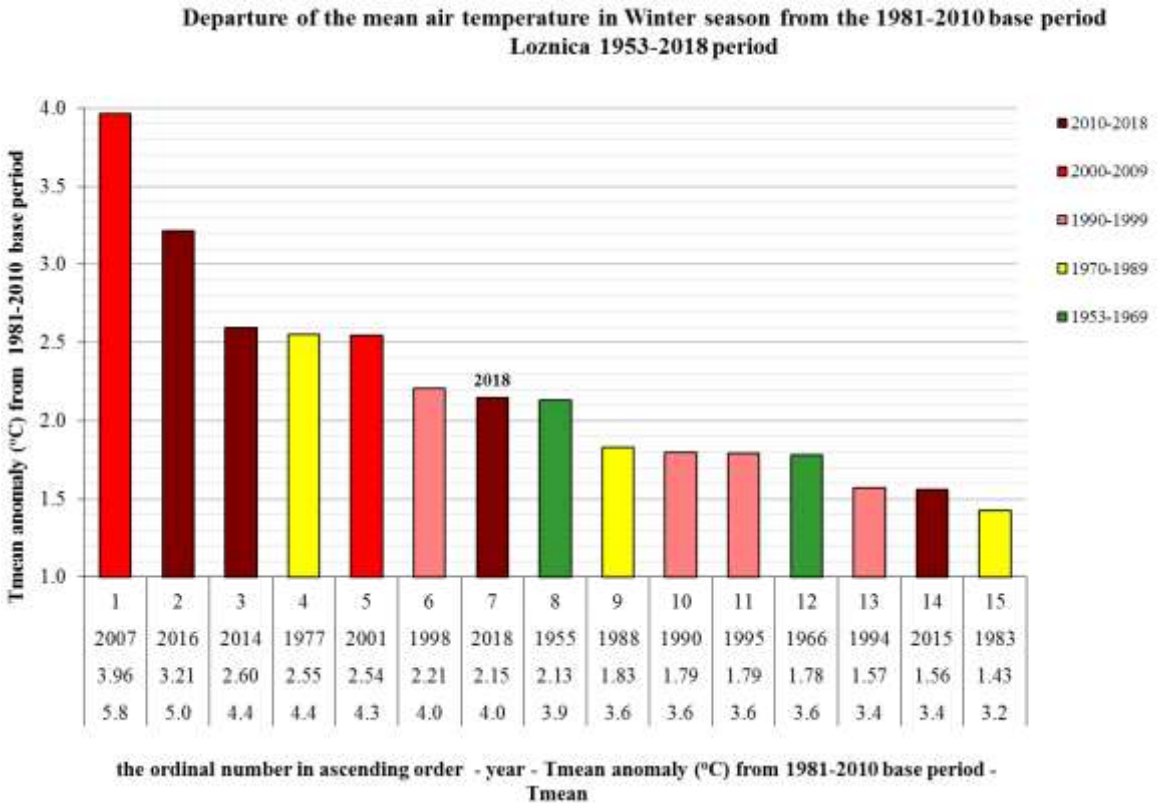


Figure 6. Rank of the warmest winter seasons for Loznica in the period from 1953 to 2018

The number of ice days, with the maximum daily air temperature below 0ºC ranged from 4 in Loznica and Valjevo to 9 days in Pozega, and on the mountains their number varied from 16 days in Sjenica to 48 days at Kopaonik. The recorded number of ice days was below the winter average for 9 to 14 days, and 1 day at Kopaonik, whereas in Sjenica that number was 16 days below the average (Figure 7).

The lowest winter air temperature of -19.5ºC was measured at Kopaonik on February 28.

The number of frost days, with the minimum daily air temperature below 0ºC ranged from 25 days in Belgrade to 65 days in Zajecar, and on the mountains from 74 days at Crni Vrh to 89 days at Kopaonik. The number of frost days was 3 to 22 days below the winter average, and at Kopaonik and Zlatibor 3 days below the average (Figure 8).

The number of days with severe frost, and minimum daily air temperature below -10ºC ranged from 4 days at Zlatibor to 22 days at Kopaonik, and in the low-lying areas up to 3 days in Kursumlija. The recorded number of days with severe frost was 2 to 11 days, at Crni Vrh 12 days below the winter average.

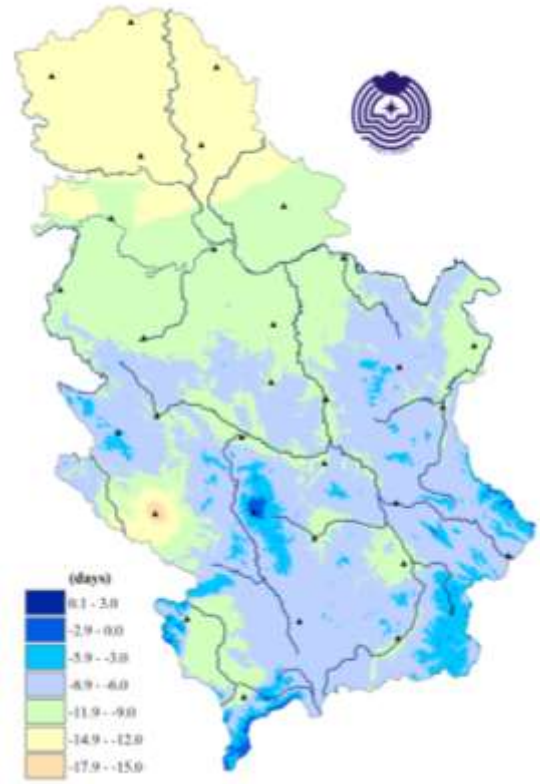


Figure 7. Deviation of the number of ice days relative to the 1981-2010 base period

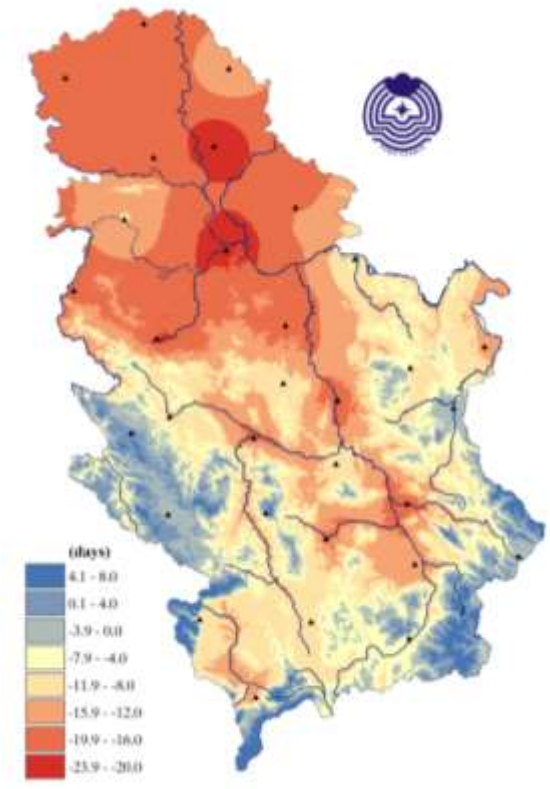


Figure 8. Deviation of the number of frost days relative to the 1981-2010 base period

In the middle of the first and third decade of December, in the first half and end of second and third decade of January as well as beginning of February, Belgrade experienced warmer periods marked by mean, maximum and minimum air temperature above the multiannual average. Colder period, with the air temperature above the multiannual average are registered at the very beginning and end of the second decade of December, middle of January and at the very end of February (Figure 9).

Figure 10 shows three-month course of the mean daily air temperature at Kopaonik for the winter of 2017/2018.

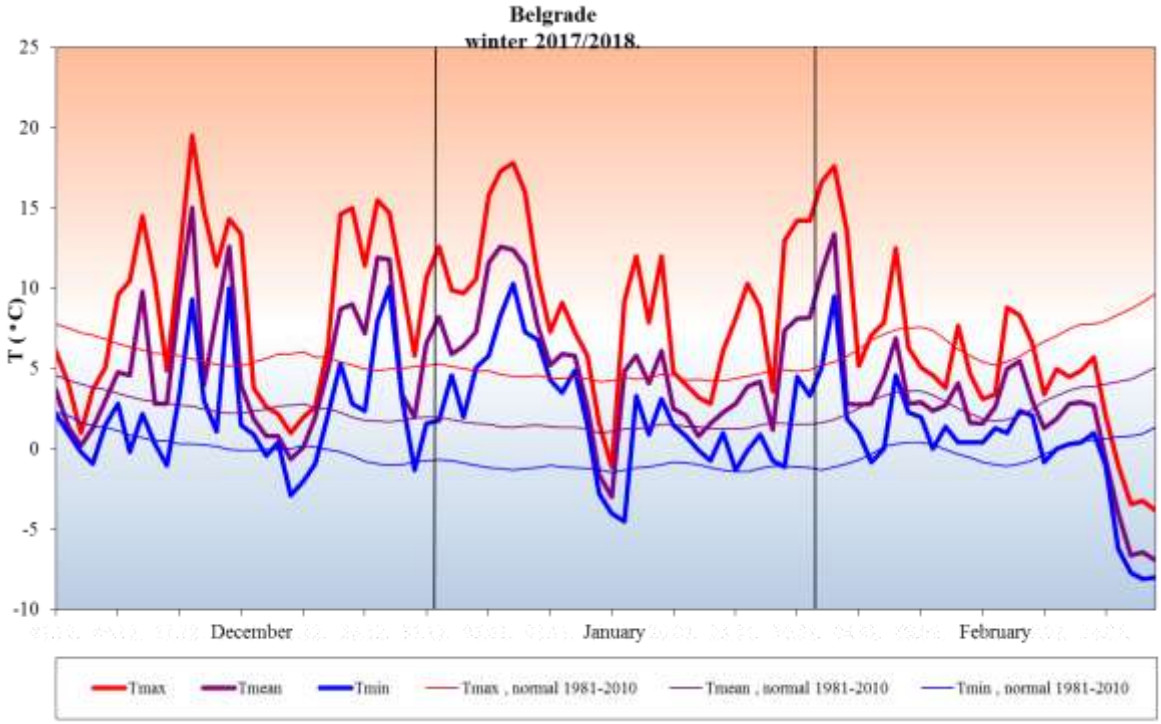


Figure 9. Three-month course of the mean, maximum and minimum air temperature for Belgrade

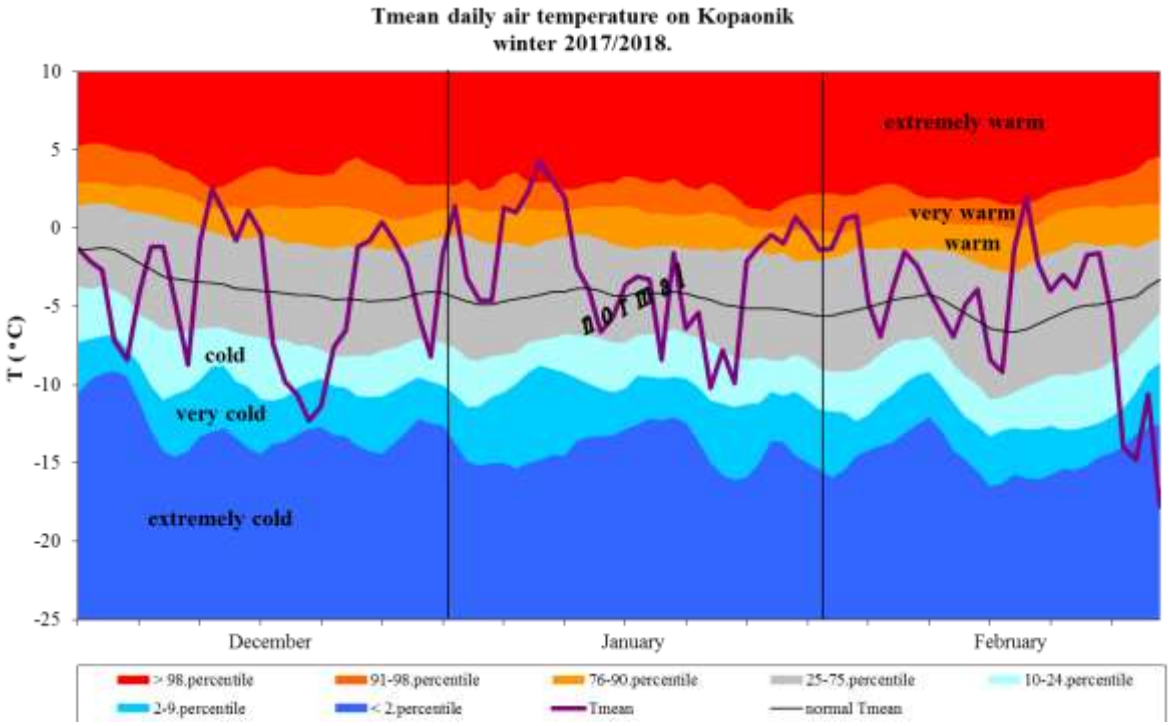


Figure 10. Three-month course of the daily mean air temperature at Kopaonik

Cold wave during winter of 2017/2018

There were no cold waves[3] recorded during the 2017/2018 winter. At the end of February, cold wave started in northern, western and eastern Serbia lasting until the beginning of March.

Precipitation

Winter precipitation totals were above the average across most of Serbia relative to the normal for the 1981-2010 base period, ranging from 124.2 mm in Banatski Karlovac up to 285,2 mm Zlatibor (Figure 11). Precpitation sums relative to the normal ranged from 98% in Belgrade to 200% in Vranje (Figure 12).

The maximum daily precipitation sum of 53.6 mm was registered in Kursumlija on December 1 which was the new all-time record.

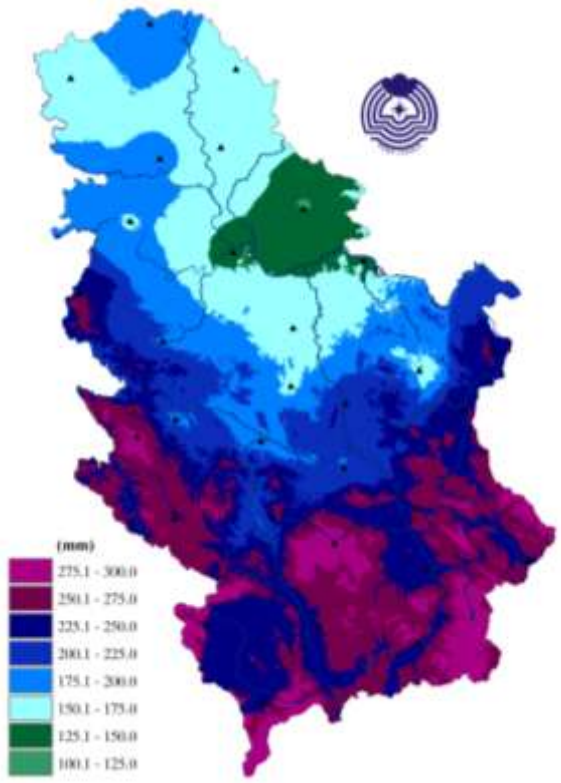


Figure 11. Spatial distribution of winter precipitation sums expressed in mm

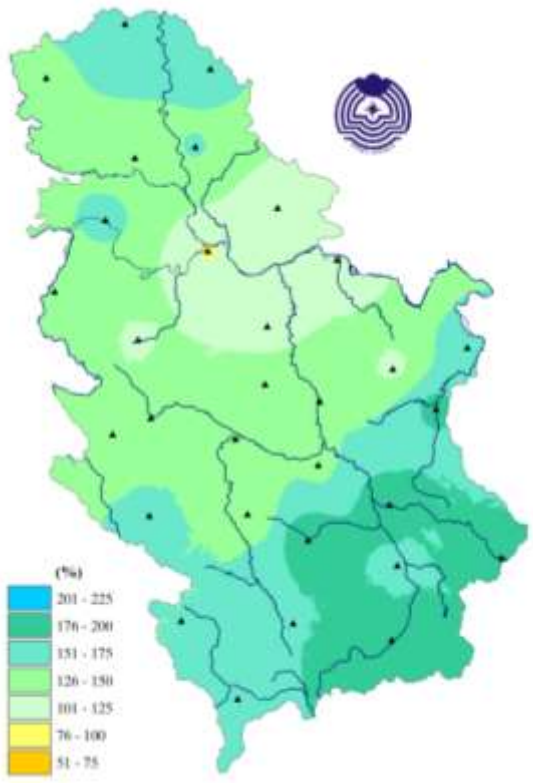


Figure 12. Spatial distribution of the winter precipitation sums expressed in % from 1981-2010 base period

[3] Cold wave is defined as period of 5 or more consecutive days with the minimum daily air temperature in the categories of very cold and extremely cold

Based on the percentile method, precipitations sums in winter were in the rainy, very rainy and extremely rainy category whereas in northeastern Serbia they were in the normal category (Figure 13).

Based on the tercile method, precipitation sums in Serbia were in the rainy category apart from northeast where they were within the average (Figure 14).

The registered number of days with precipitation of 1mm and above in winter ranged from 24 days in 24 in Banatski Karlovac, Veliko Gradiste and Kragujevac to 42 at Kopaonik. The recorded number of days with precipitation in Cuprija was 1 day below the average, whereas on all other meteorological stations it was above the average, up to 12 days above the average in eastern Serbia (Figure 15).

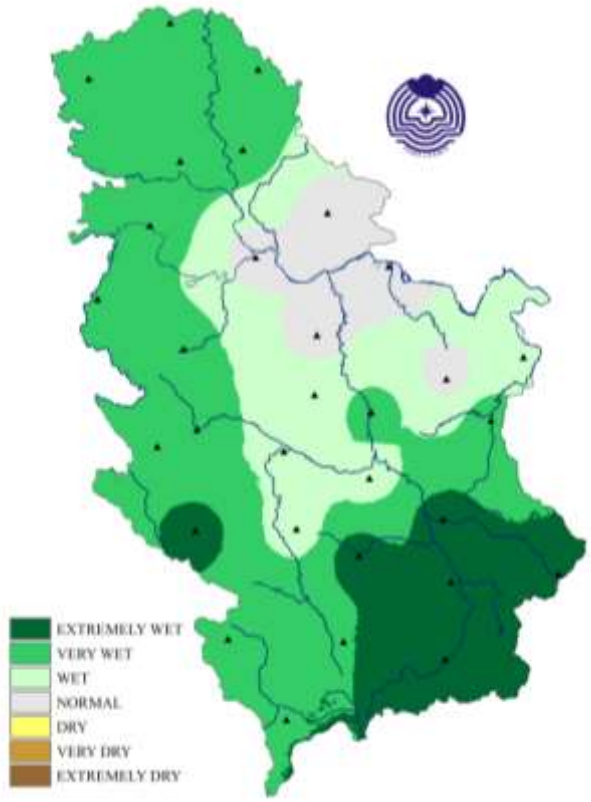


Figure 13. Precipitation sums based on percentile method

Figure 14. Precipitation sums based on tercile method

The number of days with the snow cover in the low-lying areas of Serbia ranged from 7 in Banatski Karlovac to 34 days in Dimitrovgrad. In the hilly-mountainous regions, the number of days with snow cover ranged from 62 in Sjenica to 90 at Kopaonik. The registered number of days with snow cover was 8 to 23 days below the winter average across most of the country, apart from Kopaonik where there was 4 days above the average (Figure 16). The maximum snow depth of 99 cm was measured at Kopaonik on January 22.

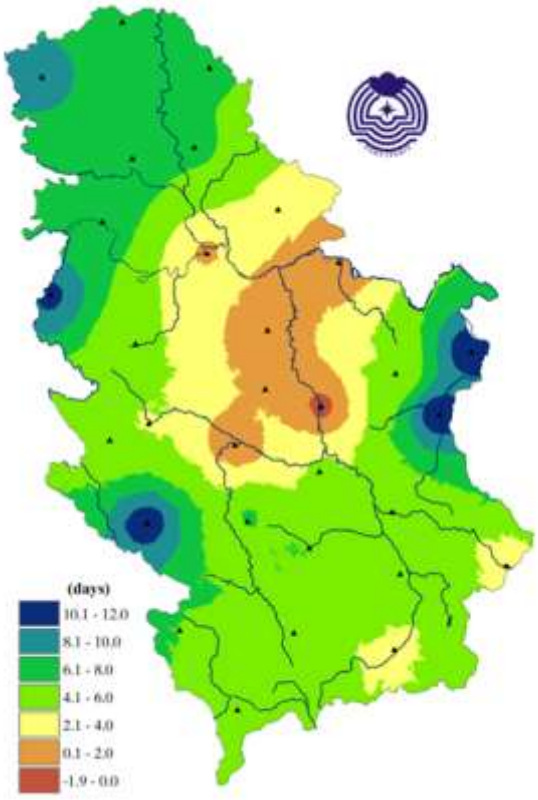


Figure 15. Deviation of the number of days with precipitation of 1.0mm and above

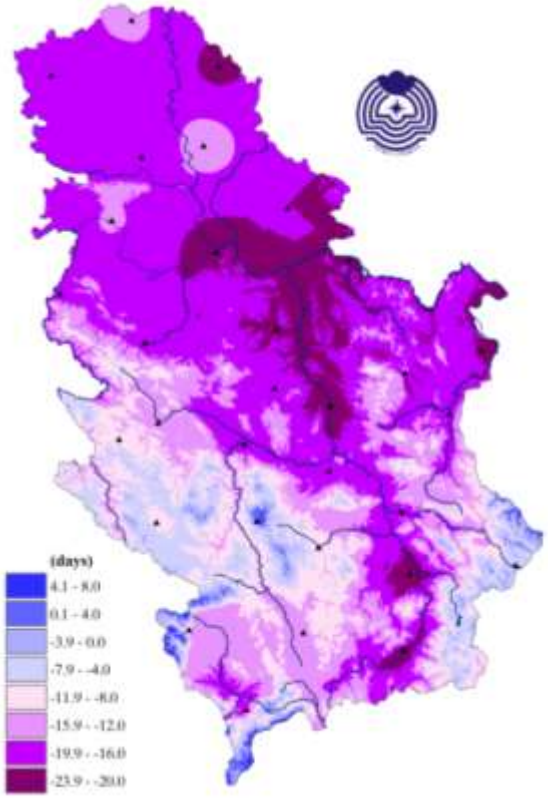


Figure 16. Deviation of the number of days with snow cover

Figure 17 and 18 show cumulative winter precipitation sums for Belgrade and Nis per months relative to the average cumulative precipitation sums.

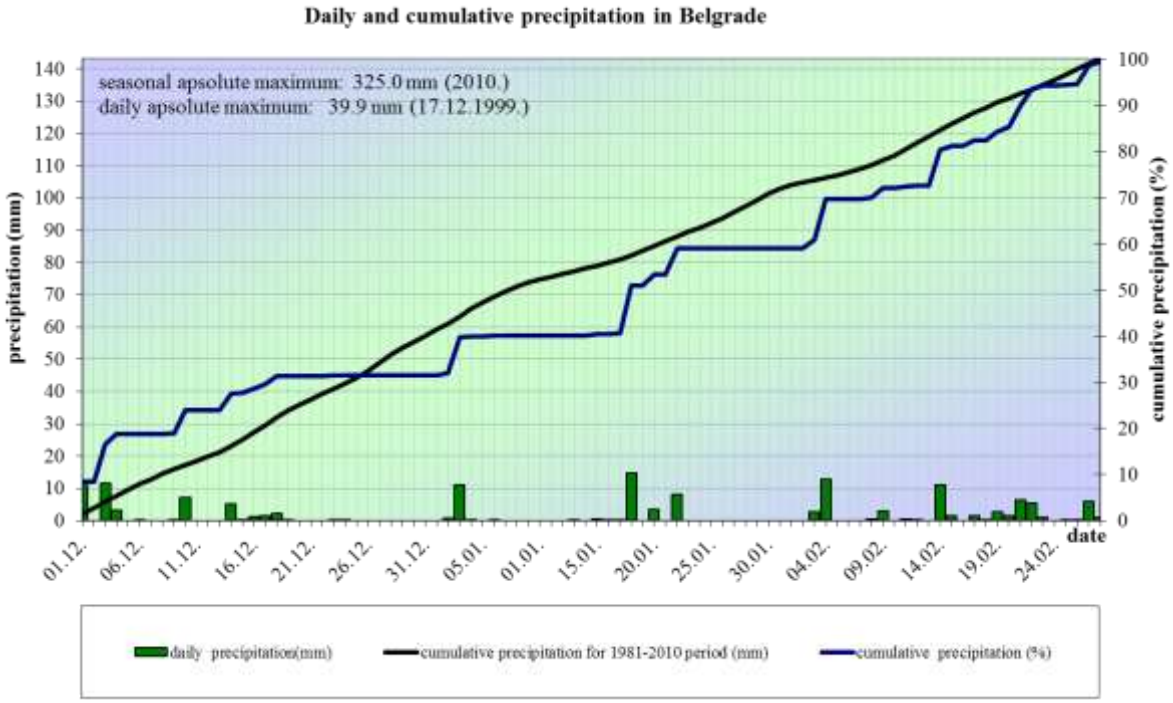


Figure 17. Cumulative precipitation sums for Belgrade

Figure 18. Cumulative precipitation sums for Niš

Figure 19 shows rank of the wettest and driest winter seasons for Serbia for the 1951-2018 base period. It can be concluded that winter of 2017/18 ranks as **the 4th wettest winter** for Serbia.

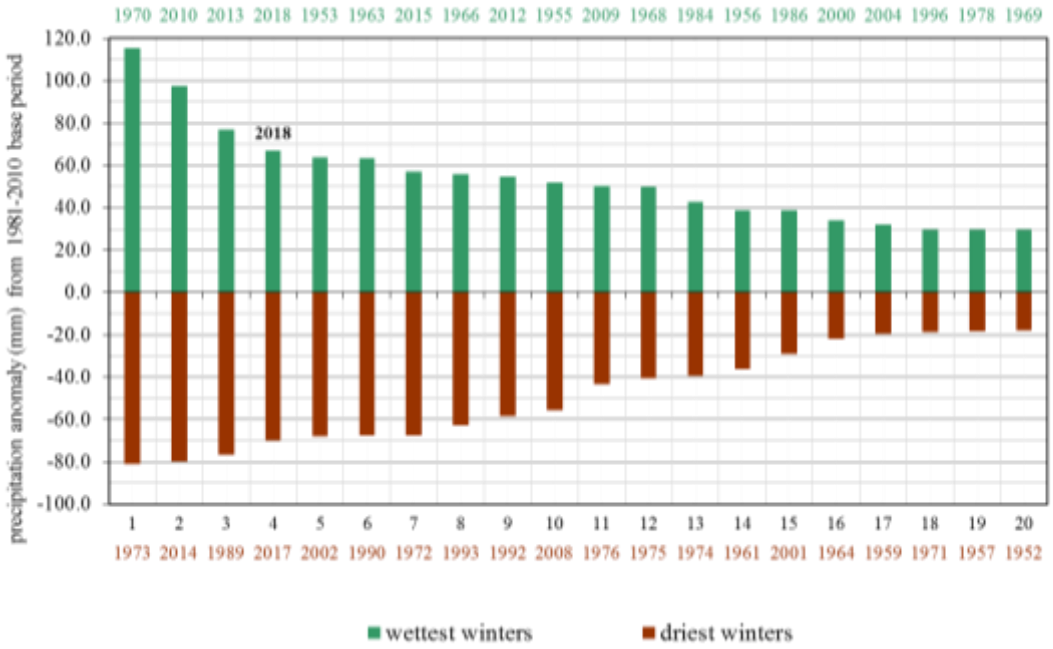


Figure 19. Rank of the wettest and driest winter seasons in Serbia for the 1951-2018 period

Winter 2017/2018 was characterized as **warm and wet**, **mean seasonal air temperature and seasonal precipitation sum** was in **the upper tercile** (Slika 20).

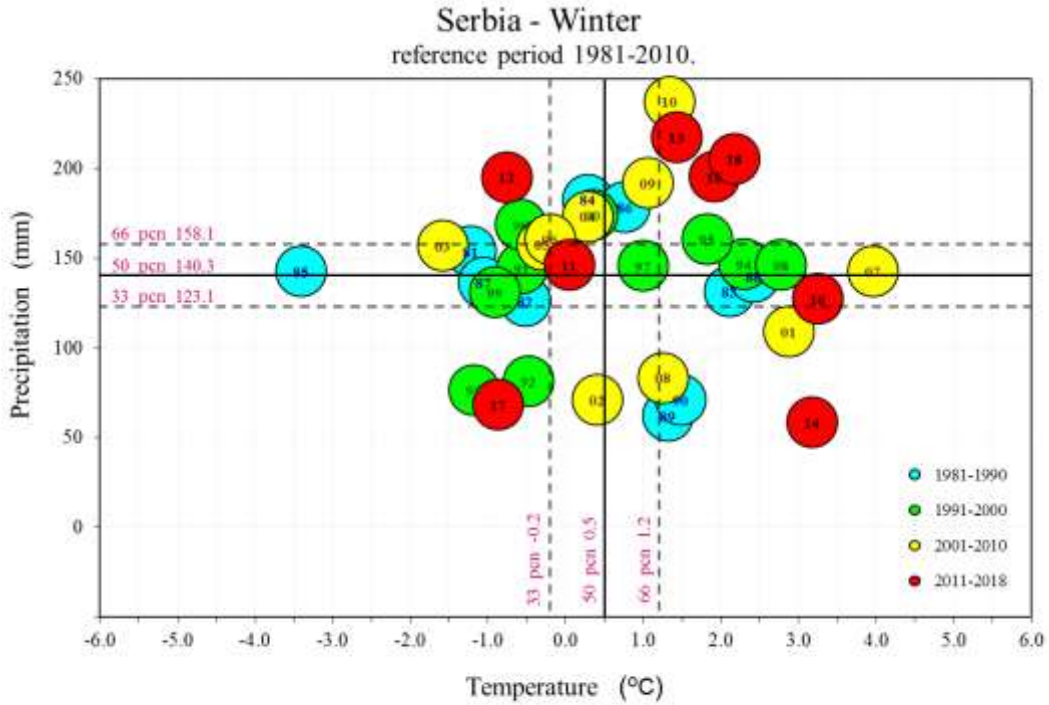


Figure 20. Assessment of the air temperature and winter precipitation sums based on the accompanying terciles relative to 1981-2010 base period

Sunshine duration (insolation)

In winter, sunshine duration ranged from 155.8 in Pozega to 250.1 hours in Negotin (Figure 21). Winter insolation ranged from 81% at Zlatibor to 120% in Kursumlija relative to the normal for the 1981-2010 base period (Figure 22).

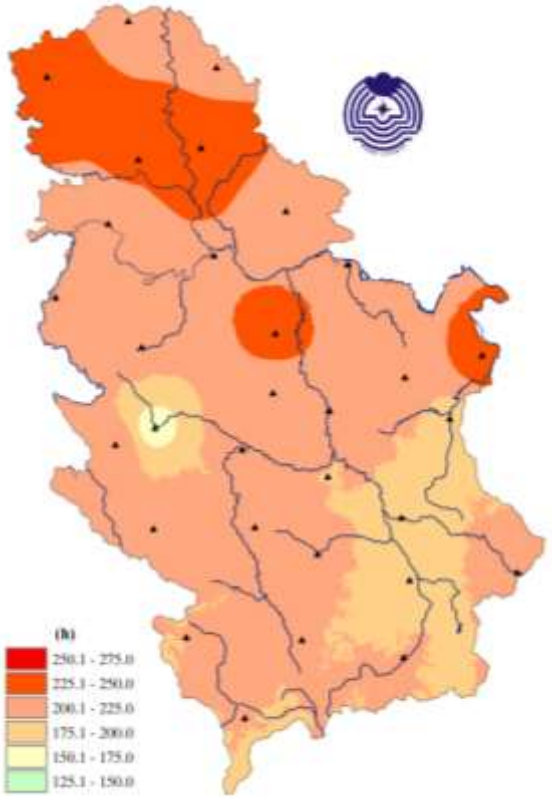


Figure 21. Insolation during winter in hours

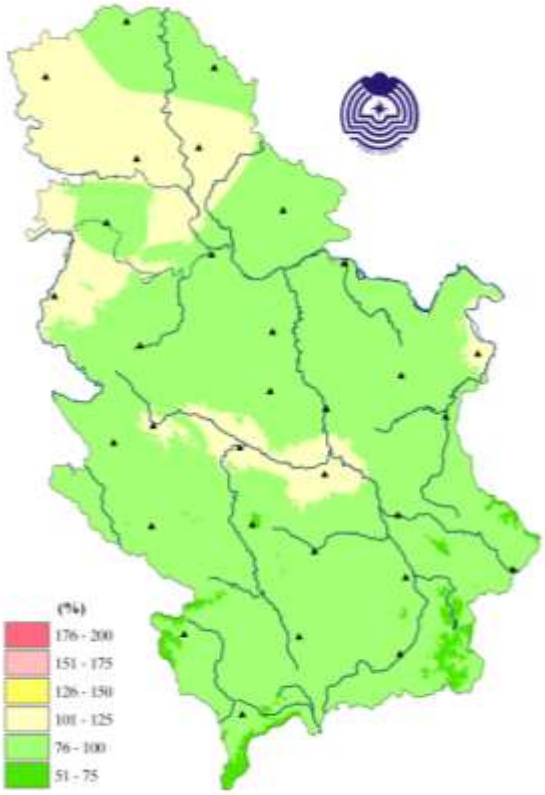


Figure 22**.** Insolation during winter as percentage of 1981-2010 base period

Analysis of the winter 2017/2018 for Serbia relative to the 1961-1990 base period

Temperature

In winter, departure of the mean air temperature from the normal, for the 1961–1990 base period ranged from 1.6ºC in Dimitrovgrad and Vranje to 2.6ºC in Loznica, and on the mountains from 1.0ºC at Kopaonik to 2.2ºC in Sjenica (Figure 23).

Based on the percentile method, mean air temperature was in the warm and very warm category across most of Serbia, whereas it was extremely warm in Zrenjanin, Loznica and Sjenica (Figure 24).

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

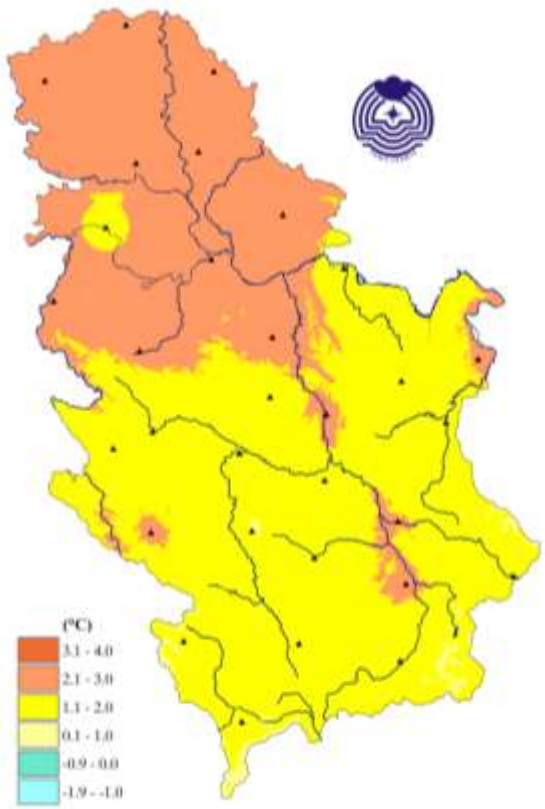


Figure 23. Departure of the mean seasonal air temperature relative to the 1961-1990 base period

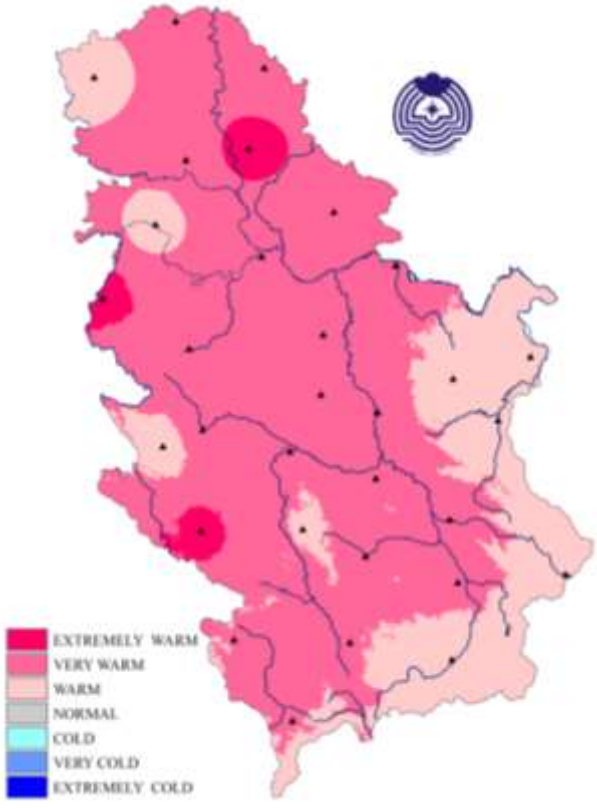


Figure 24. Mean seasonal air temperature based on percentile method relative to the 1961-1990 base period

Precipitation

In most of Serbia, winter precipitation sums were above the average relative to the normal for the 1961-1990 base period. Precipitation sums ranged from 92% in Banatski Karlovac to 199% in Kursumlija compared to the normal (Figure 25).

Based on the percentile method, winter precipitation sums were in the following categories: very rainy and extremely rainy in northern, eastern, western and southern Serbia, normal in northeast and some central parts of the country, elsewhere it was in the rainy category (Figure 26).

Based on the tercile method, precipitation sums were in the rainy category apart from northeast where it was within the average.

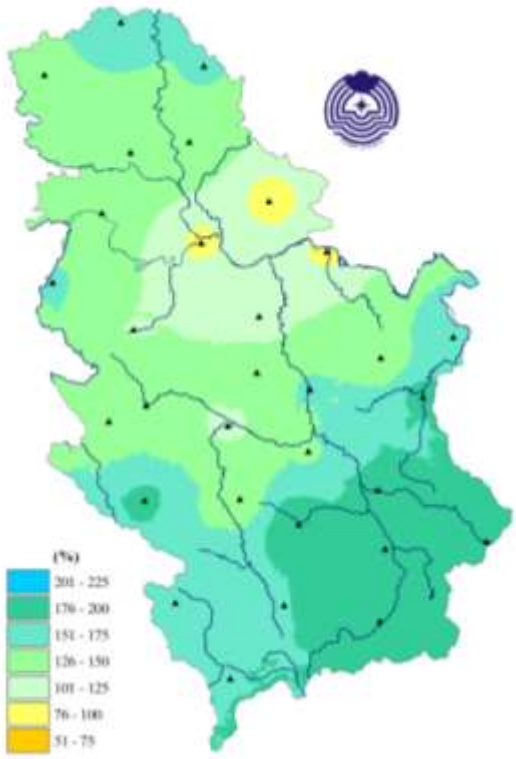


Figure 25. Seasonal precipitation sums expressed as the percentages of normal relative to the 1961-1990 base period

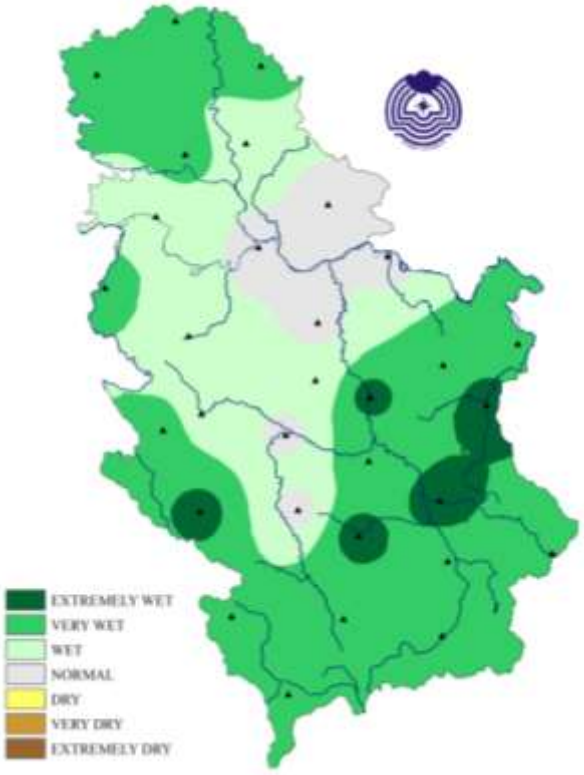


Figure 26. Seasonal precipitation sums based on percentile method relative to the 1961-1990 base period

Note: Climatological analysis of meteorological elements was performed on the basis of the data obtained from 28 main meteorological stations.