VERIFICATION OF THE SEECOF–26 WINTER 2021/2022 CLIMATE OUTLOOK AND SEASONAL BULLETIN FOR THE TERRITORY OF SERBIA

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Temperature

The SEECOF-26 outlook for the winter 2021/2022 in Serbia indicated normal- to above-normal temperature in Serbia with 40% probability relative to the 1981–2010 climatological base period (*Figure* A).

Climatological monitoring showed that the winter 2021/2022 was warm in almost entire Serbia, with above-normal temperature based on the tercile method (*Figure* B). The outlook for a warm/normal winter was correct, in the lowlands of Serbia it was warmer than average, while in the highlands winter temperature was within the average.

OUTLOOK – WINTER **2021/2022**

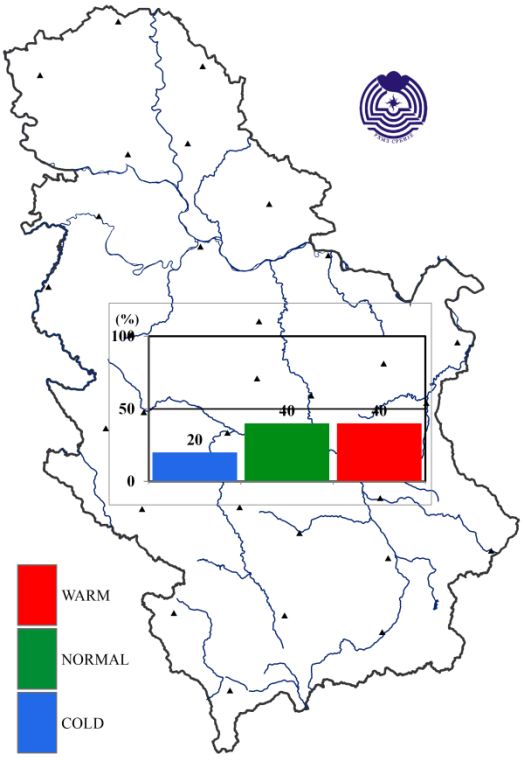


Figure A. SEECOF-26 - winter temperature outlook

MONITORING – WINTER **2021/2022**

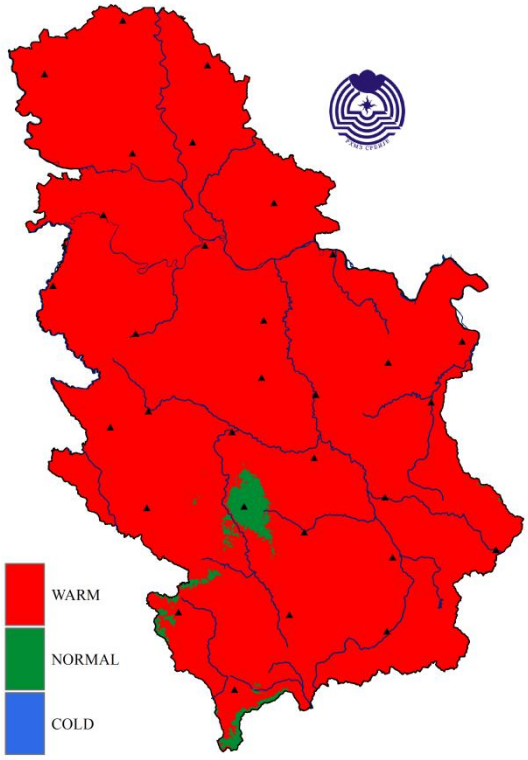


Figure B. Monitoring of the winter temperature using tercile method compared to the 1981-2010 base period

Precipitation

According to the SEECOF-26 outlook for the winter 2021/2022, approximately equal probabilities for below, near or above normal precipitation were indicated for Serbia, relative to the 1981–2010 climatological base period (*Figure* C), hence climatology (average seasonal precipitation) was suggested.

Based on the climatological monitoring of precipitation, the winter of 2021/2022 was wet in most of Serbia whilst average precipitation sums were recorded in some parts of the southern, eastern and northern Serbia (*Figure* D). Below average precipitation totals were registered in northernmost part of Serbia. The outlook for average winter precipitation sums was correct for some parts of Serbia.

OUTLOOK – WINTER **2021/2022**

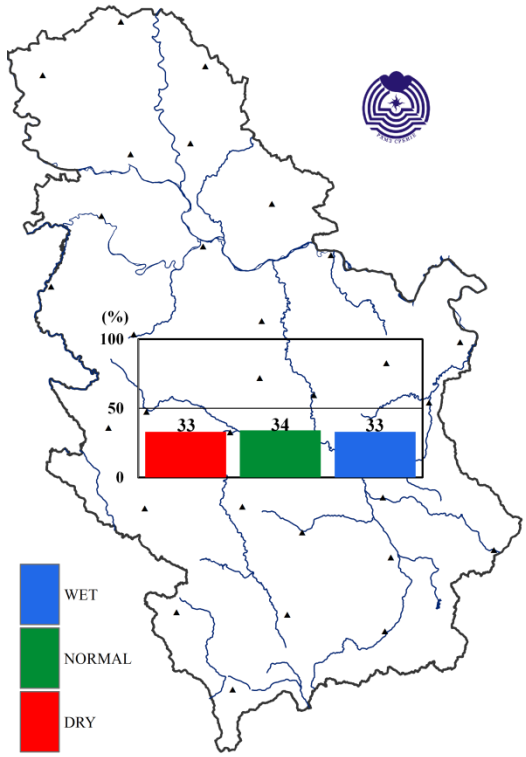


Figure C. SEECOF-26 - winter precipitation outlook

MONITORING – WINTER **2021/2022**

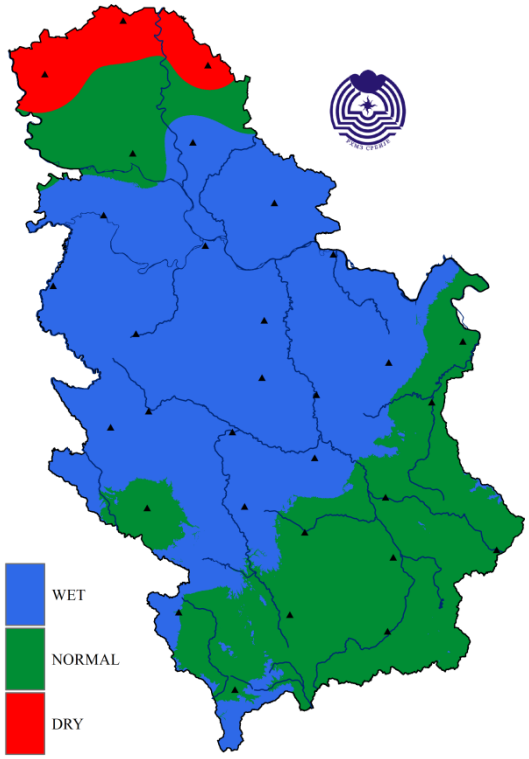


Figure D. Monitoring of the winter precipitation using tercile method compared to the 1981-2010 base period

Winter 2021/2022			**Air Temperature (°C)**			
Station	Rank*	Rank**	33	50	66	Observed value
Belgrade (1887-2022)	13	8	1.5	2.4	3.0	4.4
Palić (1945-2022)	8	7	-0.1	0.5	1.5	3.0
Sombor (1941-2022)	9	8	0.0	0.9	1.8	3.1
Novi Sad (1948-2022)	10	8	0.4	1.1	1.8	3.4
Zrenjanin (1943-2022)	9	8	0.3	1.0	1.8	3.3
Kikinda (1948-2022)	9	8	0.1	0.9	1.7	3.0
Banatski Karlovac (1985-2022)	11	11	0.7	1.4	2.0	2.9
Loznica (1952-2022)	8	7	0.7	1.8	2.5	4.1
Sremska Mitrovica (1925-2022)	13	8	0.4	0.9	1.6	3.1
Valjevo (1926-2022)	12	8	0.7	1.3	2.2	3.5
Kragujevac (1925-2022)	16	11	0.9	1.5	2.3	3.4
Smederevska Palanka (1939-2022)	14	10	0.7	1.5	2.1	3.3
Veliko Gradište (1926-2022)	18	12	0.4	1.0	1.6	2.6
Crni Vrh (1966-2022)	12	11	-3.6	-3.2	-2.1	-1.4
Negotin (1927-2022)	3	3	0.7	1.1	1.8	4.4
Zlatibor (1950-2022)	19	14	-2.2	-1.8	-0.8	-0.5
Sjenica (1946-2022)	22	14	-3.4	-2.5	-2.0	-1.7
Pozega (1952-2022)	15	11	-1.3	-0.7	0.3	0.8
Kraljevo (1926-2022)	15	10	0.5	1.1	2.1	3.0
Kopaonik (1949-2022)	27	21	-5.0	-4.6	-3.8	-4.4
Kursumlija (1952-2022)	11	9	0.3	1.0	1.5	2.7
Krusevac (1927-2022)	16	11	0.7	1.1	1.9	3.0

Cuprija (1948-2022)	16	12	0.4	1.2	1.7	2.9
Nis (1925-2022)	14	10	1.1	1.6	2.3	3.5
Leskovac (1948-2022)	17	13	0.3	0.9	1.7	2.6
Zajecar (1929-2022)	5	4	0.0	0.4	1.1	3.2
Dimitrovgrad (1945-2022)	14	10	-0.5	0.0	1.1	2.0
Vranje (1926-2022)	21	12	0.3	1.0	1.7	2.3

*Rank –period of stations work (warmest season)
**Rank – 1981-2022 period (warmest season)

Winter 2021/2022			**Precipitation sums (mm)**			
Station	Rank*	Rank**	33	50	66	Observed Value
Belgrade (1887-2022)	6	2	129.8	152.3	158.3	225.7
Palić (1936-2022)	62	31	90.1	104.4	121.5	82.1
Sombor (1931-2022)	64	30	104.2	114.8	123.0	101.0
Novi Sad (1945-2022)	39	21	109.9	119.1	133.5	124.2
Zrenjanin (1925-2022)	30	12	106.5	115.7	127.0	141.4
Kikinda (1925-2022)	68	30	98.0	105.5	121.2	96.6
Banatski Karlovac (1946-2022)	10	2	108.3	122.7	132.5	182.5
Loznica (1925-2022)	31	17	166.4	171.6	201.4	204.6
Sremska Mitrovica (1925-2022)	13	2	103.0	115.9	130.1	180.2
Valjevo (1926-2022)	9	5	149.5	157.6	173.3	214.2
Kragujevac (1925-2022)	4	3	113.0	120.0	134.0	202.8
Smederevska Palanka (1926-2022)	4	3	121.8	132.7	157.6	212.6
Veliko Gradište (1926-2022)	20	8	120.8	147.9	161.3	180.4

Crni Vrh (1966-2022)	17	16	127.6	143.8	170.7	176.0
Negotin (1941-2022)	49	25	105.9	137.3	186.9	132.9
Zlatibor (1950-2022)	6	5	204.3	225.1	237.8	299.7
Sjenica (1925-2022)	35	21	140.9	151.4	177.6	160.9
Pozega (1925-2022)	9	2	124.3	147.5	157.6	207.1
Kraljevo (1926-2022)	13	6	126.9	137.3	156.8	211.6
Kopaonik (1949-2022)	1	1	158.1	204.0	232.1	346.0
Kursumlija (1925-2022)	33	18	123.5	150.9	174.5	168.4
Krusevac (1925-2022)	19	12	115.1	133.2	155.6	175.1
Cuprija (1947-2022)	14	9	127.5	148.1	163.1	206.8
Nis (1925-2022)	36	19	117.7	137.1	150.6	144.1
Leskovac (1925-2022)	39	25	127.3	150.4	161.8	145.8
Zajecar (1925-2022)	51	27	103.7	136.3	146.6	129.9
Dimitrovgrad (1926-2022)	37	19	111.6	120.4	143.9	135.2
Vranje (1926-2022)	51	22	111.7	126.9	137.1	128.4

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

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

Country	Seasonal temperature DJF		Seasonal precipitation DJF		High Impact Events
	Observed	SEECOF-26 climate outlook for temperature	Observed	SEECOF-26 climate outlook for precipitation	
Serbia (1)	Above normal in the lowlands, average in the highlands	**Normal - to above-normal** (20, 40, 40) in entire Serbia	Above normal in most of Serbia	**No predictive signal** (33, 34, 33) in entire Serbia	❖ ***12th warmest winter for Serbia since 1951, 13th warmest for Belgrade since 1888, 3rd warmest for Negotin since 1928, 5th warmest for Zajecar since 1930*** ❖ ***17th wettest winter for Serbia since 1951, wettest on record for Kopaonik since 1950*** ❖ ***Record-breaking daily precipitation sum measured at Crni Vrh*** ❖ ***Record-breaking winter insolation for Palic***

Analysis of the winter season 2021/22 for Serbia relative to 1991-2020 base period

Temperature

Winter 2021/22 ranks as **the 12th warmest for Serbia since 1951** (*Figure 1*) and the **13th warmest for Belgrade** since 1888. Mean winter air temperature was 2.4°C which is 1.4°C above the 1991-2020 average. Belgrade observed mean winter air temperature of 4.4°C which is 1.6°C above the 1991-2020 average. Winter 2021/22 ranks as the 3rd warmest for Negotin since 1928 (*Figure 2*) and the 5th warmest for Zajecar since 1930.

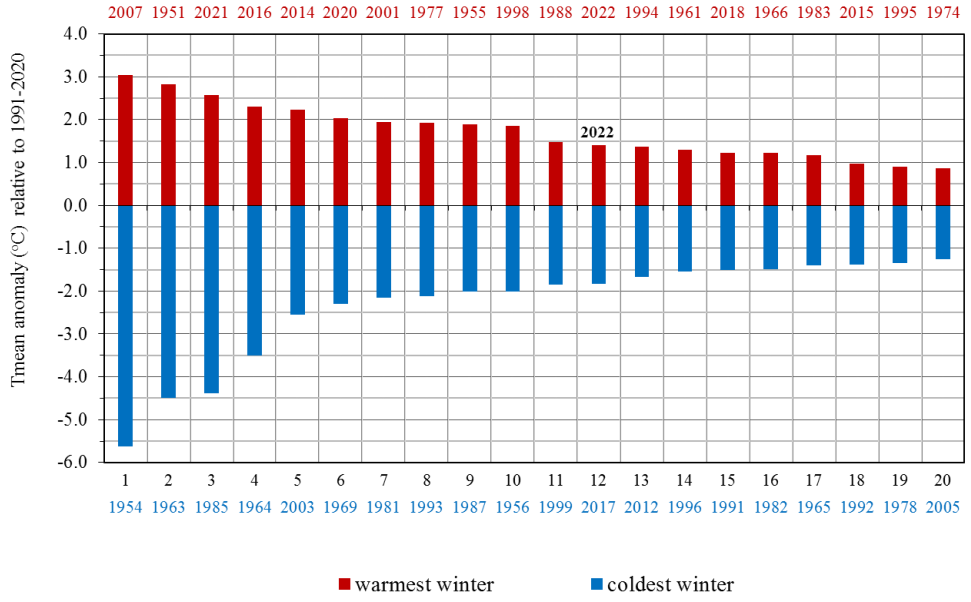


Figure 1. Rank of twenty warmest and coldest winter seasons in Serbia for the 1951-2022 period

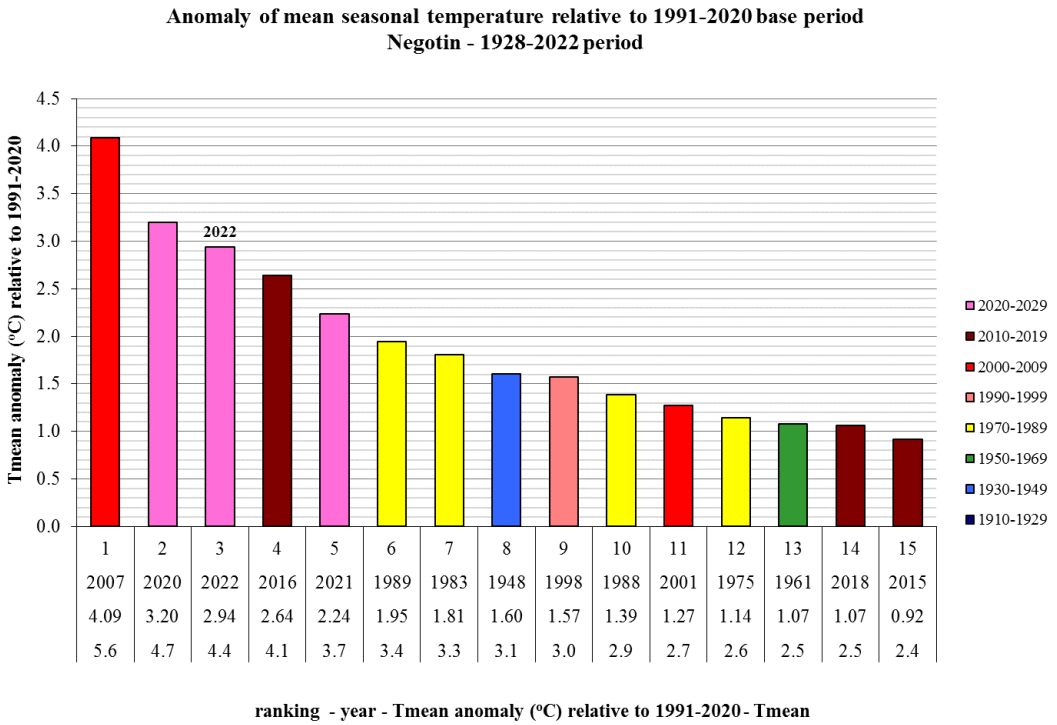


Figure 2. Rank of the warmest winters in Negotin for the 1928-2022 period

Mean winter air temperature ranged from 0.8ºC in Pozega to 4.4ºC in Belgrade and Negotin, and in the upland from -0.5ºC at Zlatibor to -4.4ºC at Kopaonik (*Figure 3*).

In winter, departure of the mean air temperature from the normal[1], for the 1991-2020 base period ranged from 1.0ºC in Pozega and Vranje to 2.9ºC in Negotin, and in the upland from -0.3ºC at Kopaonik to 1.1ºC at Crni Vrh (*Figure 4*).

Based on the percentile method, mean winter air temperature was in the warm category in most of Serbia, and in the very warm category in Negotin and Zajecar (*Figure 5*).

Based on the tercile method, mean winter air temperature was in the warm category in almost entire Serbia (*Figure 6*).

[1] Term normal refers to climatological standard normal, that is, the average value of a particular climate event, calculated for the period from 1 January 1991 to 31 December 2020

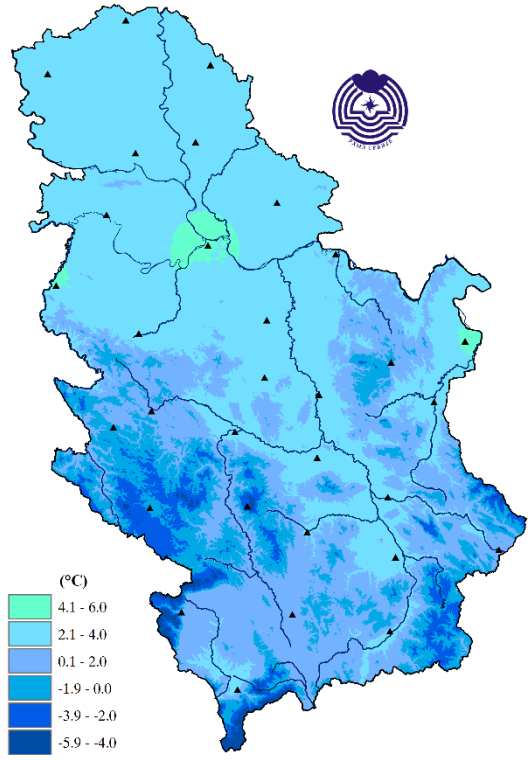


Figure 3. Spatial distribution of mean winter air temperature

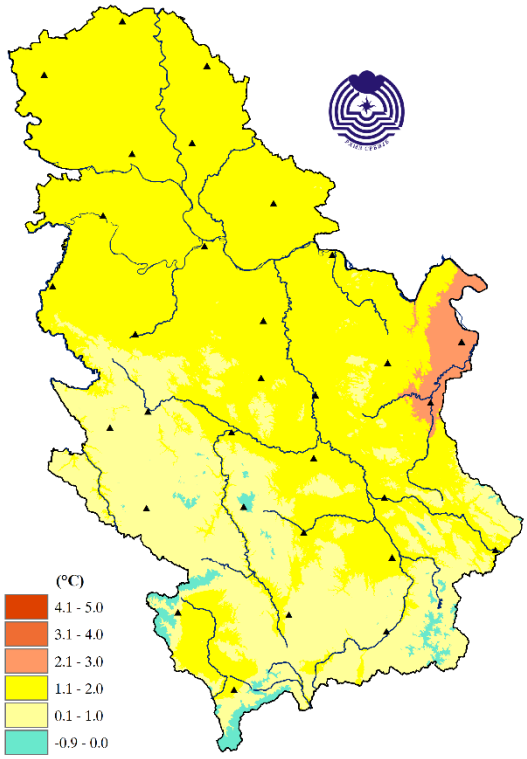


Figure 4. Spatial distribution of mean winter air temperature anomaly from the normal

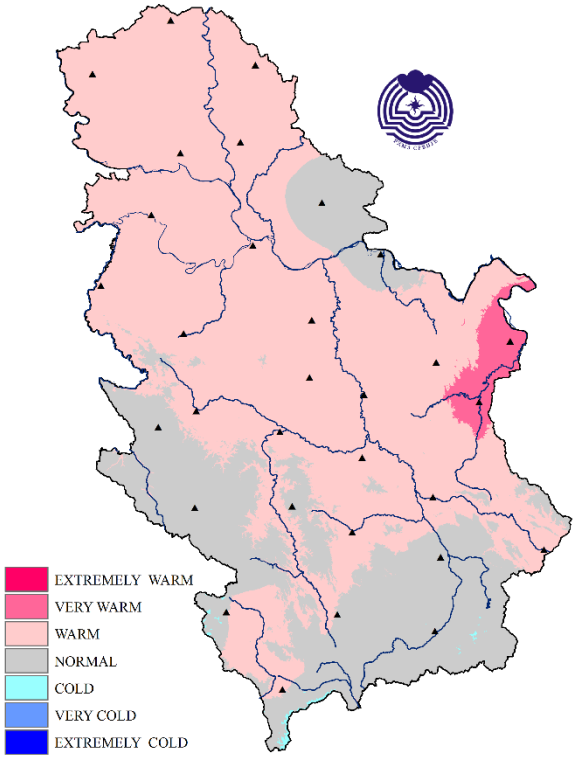


Figure 5. Spatial distribution of mean winter air temperature according to the percentile method

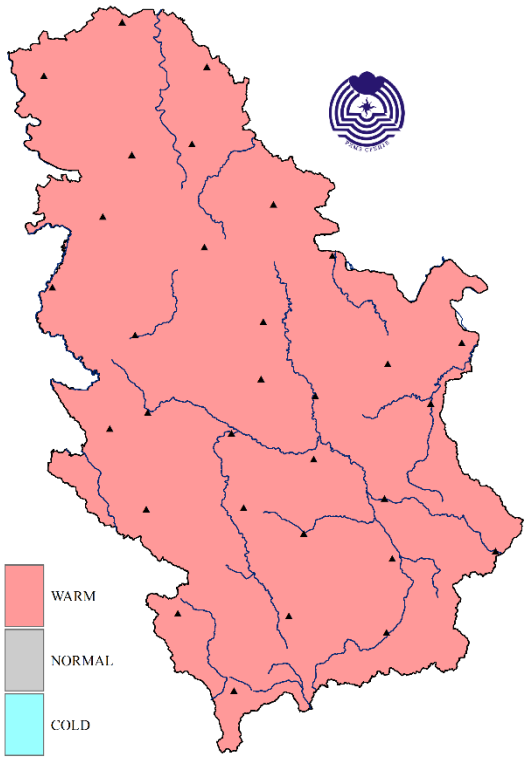


Figure 6. Spatial distribution of mean winter air temperature according to the tercile method

The highest winter air temperature of 21.4ºC was measured in Leskovac on February 19.

Number of ice days, with the maximum daily air temperature below 0ºC, was below the average, between 5 and 15 days below the average in most of Serbia. Number of ice days ranged from 1 day in Zajecar to 7 days in Banatski Karlovac and Kragujevac, and in the upland from 28 days in Sjenica to 54 days at Kopaonik (*Figure 7*).

The lowest winter air temperature of -24.8ºC was measured in Sjenica on January 25.

Number of frost days, with the minimum daily air temperature below 0ºC, ranged from 24 days in Belgrade to 64 days in Dimitrovgrad, and in the mountains from 71 days at Zlatibor to 87 days at Kopaonik. Number of frost days was 5 to 19 days below the winter average, and on the mountains up to 4 days above the average (*Figure 8*).

In the lowland, severe frost was recorded during 6 days, with the minimum daily air temperature below -10ºC, and on the mountains, number of frost days ranged from 6 days at Zlatibor and Crni Vrh to 27 days at Kopaonik, which is 1 to 12 days below the average.

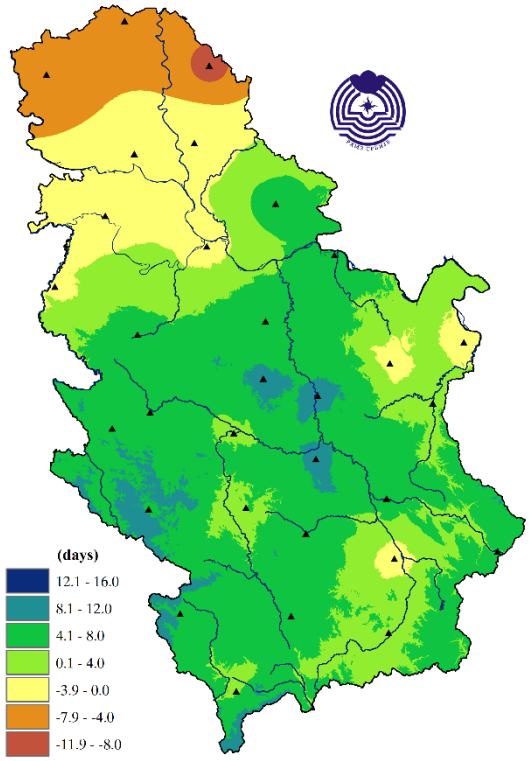


Figure 7. Deviation of the number of ice days from the normal

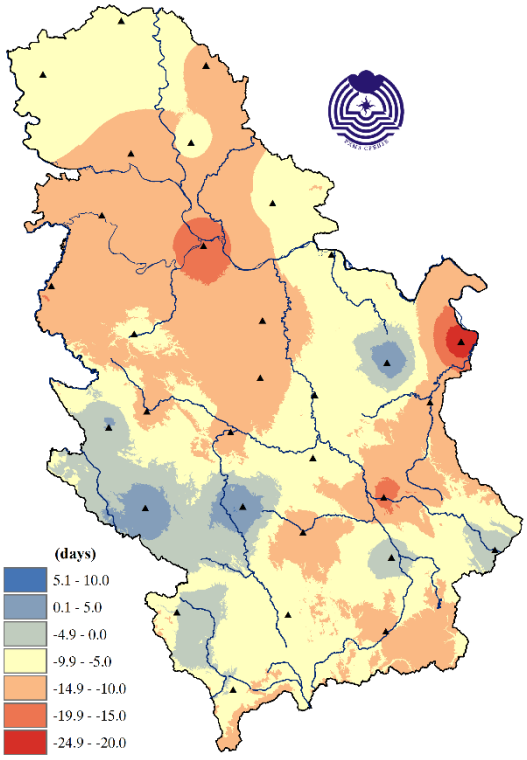


Figure 8. Deviation of the number of frost days from the normal

Warmer periods in Belgrade were observed when mean, maximum and minimum air temperature were above the multiannual average, at the beginning and at the end of December, during the first decade of January and during most of February. Colder periods, with air temperature below the multiannual average were recorded at the beginning of the third decade of December and during second and third decade of January (*Figure 9*).

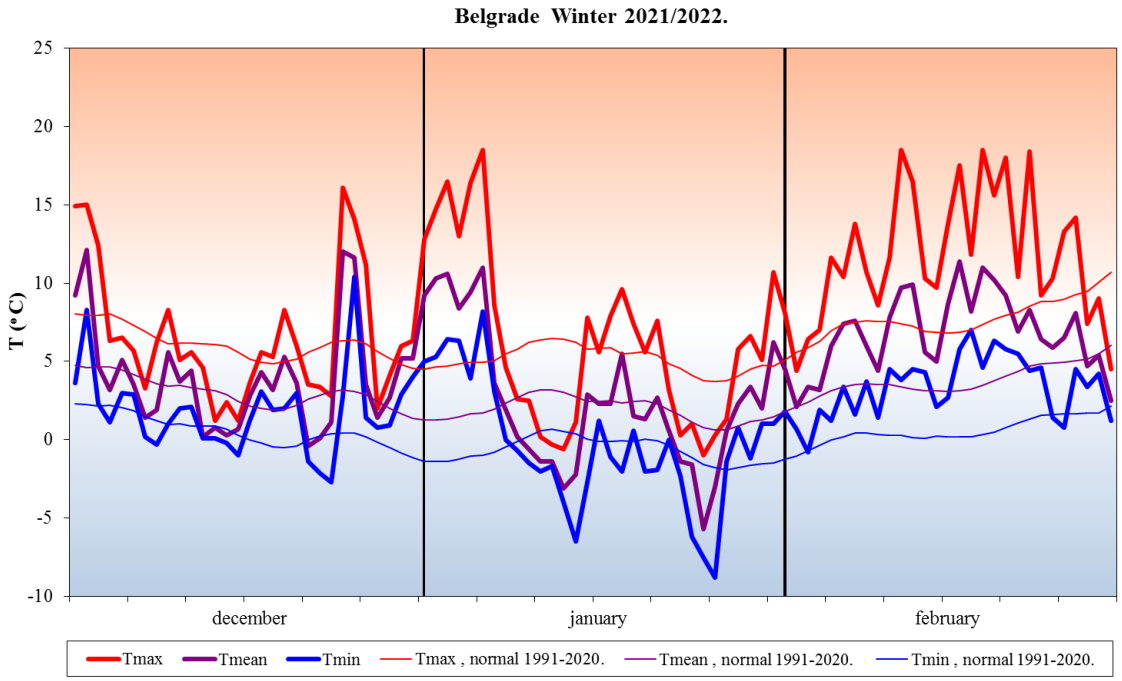


Figure 9. Three–month course of the mean, maximum and minimum daily air temperature in Belgrade

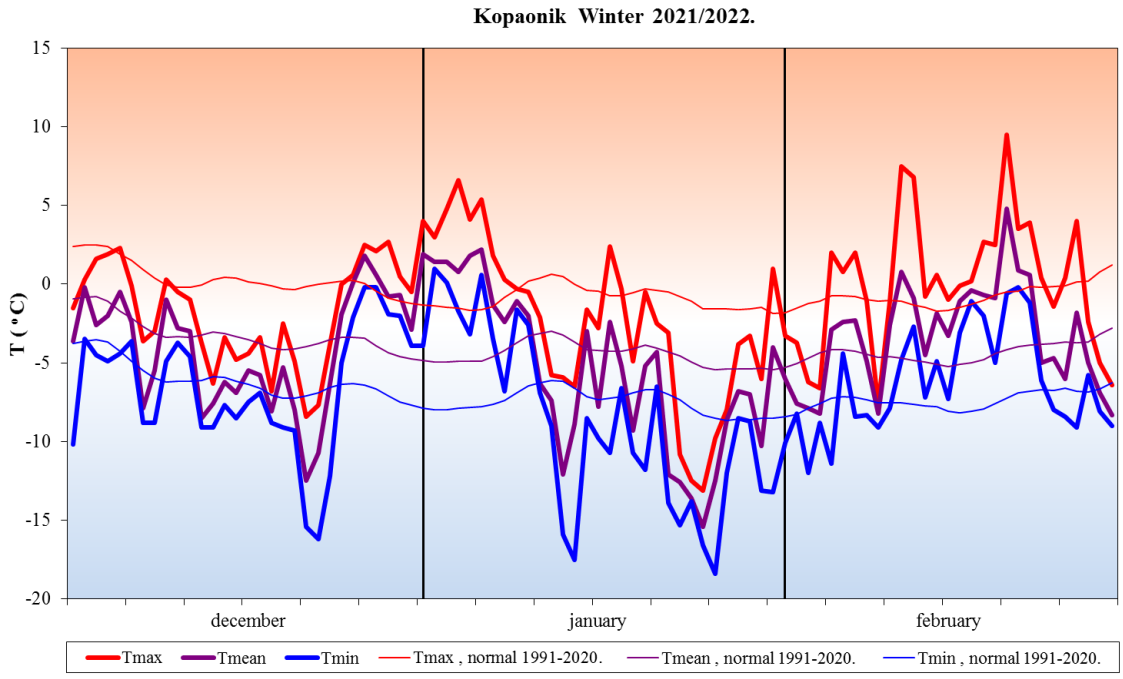
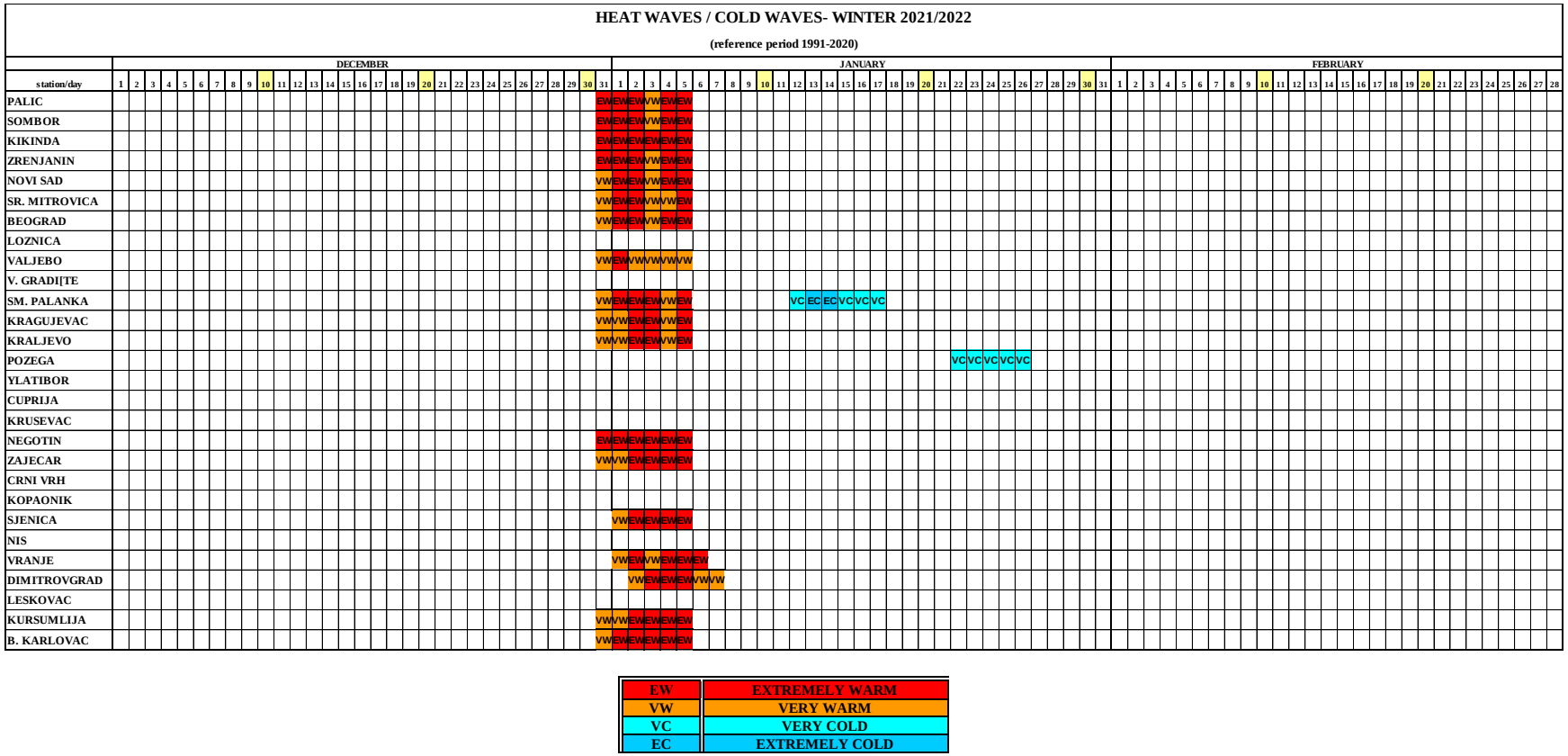


Figure 10. Three–month course of the mean, maximum and minimum daily air temperature at Kopaonik

Cold wave/heat wave

In winter 2021/22, cold wave[2] was recorded in the period from January 10 to 15 in Smederevska Palanka, and in the period from January 22 to 27 in Pozega. One heat wave[3] was registered across most of Serbia lasting from December 31 to January 6 (*Chart 1*).

Chart 1



[2] Coldwave, according to the percentile method, is a period during which minimum daily air temperature is in the very cold and extremely cold categories for 5 days or longer
[3] 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 5 days or longer

Precipitation

Winter of 2021/2022 ranks as the 17th wettest for Serbia (*Figure 11*) in the period from 1951 and **the wettest on record for Kopaonik** since 1950 (*Figure 12*).

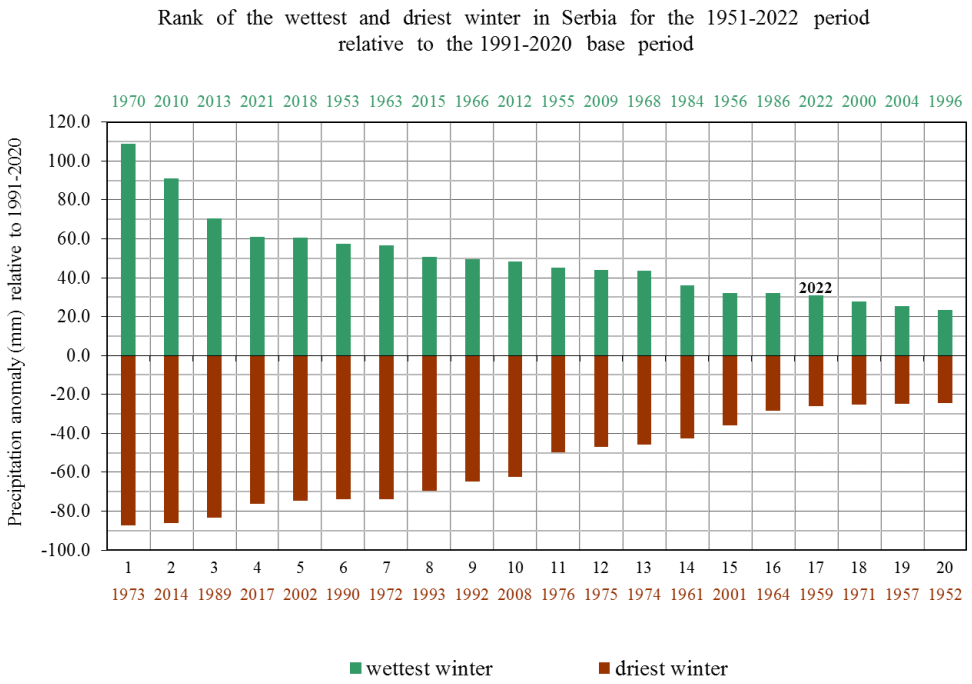


Figure 11. Rank of the wettest and driest winter seasons for Serbia for the 1951-2022 period

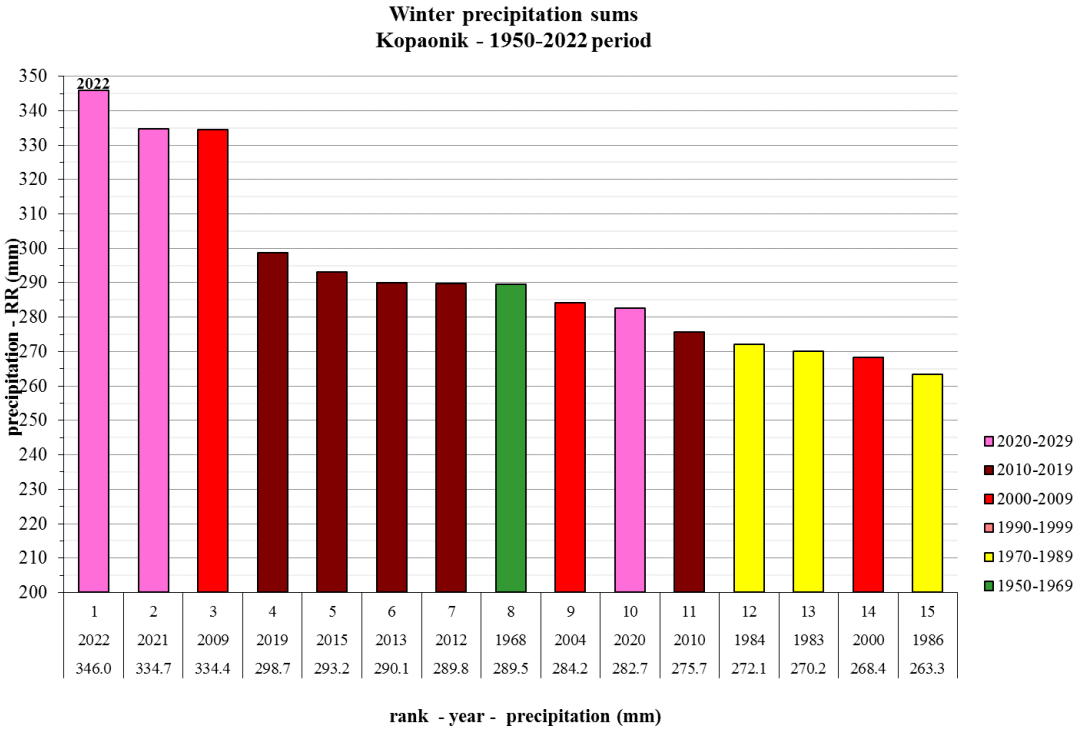


Figure 12. Rank of the wettest winters at Kopaonik

Figure 13 shows cumulative winter precipitation sums for Belgrade per months relative to the average cumulative precipitation sums.

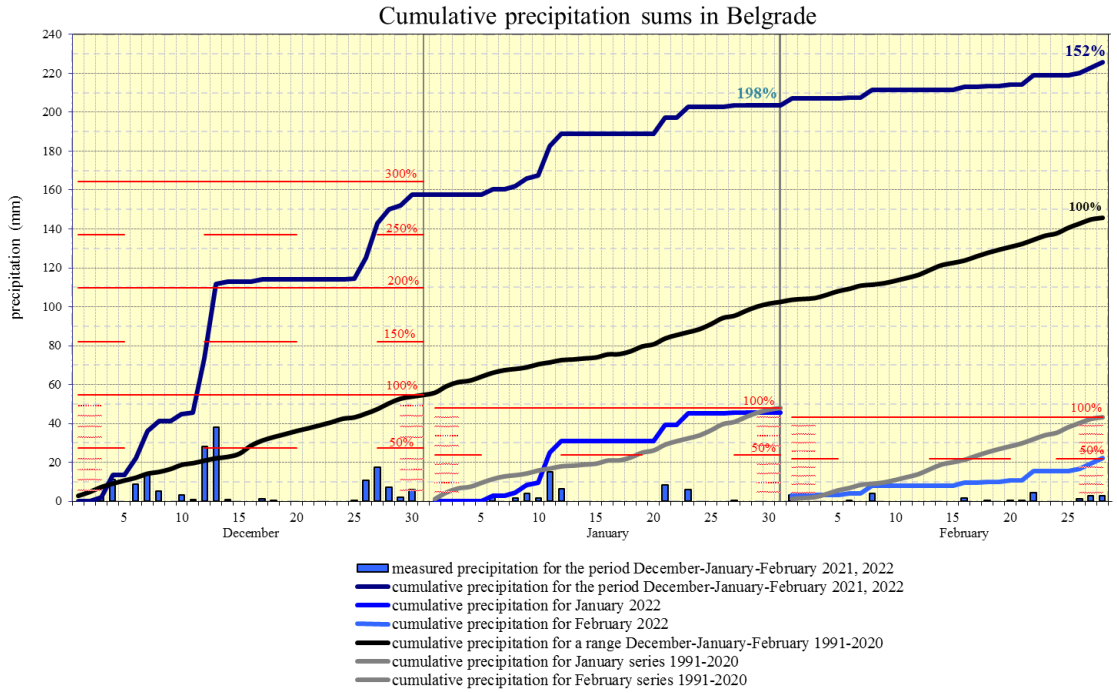


Figure 13. Cumulative precipitation sums for Belgrade

Winter precipitation totals in most of Serbia were above the average. Precipitation sums (*Figure 14)* were in a range from 82.1 mm on Palic to 225.7 mm in Belgrade, and in the upland from 160.9 mm in Sjenica to 346.0 mm at Kopaonik. **Kopaonik observed record-breaking winter precipitation sums (346,0 mm)** thereby besting the previous record of 334.7 mm set in 2020/21.

Precipitation sums expressed in the percentages of normal (*Figure 15*) for the 1991-2020 base period ranged from 72% on Palic to 155% in Kragujevac, and in the upland from 97% in Sjenica to 165% at Kopaonik.

On December 12, 2021, **Crni Vrh observed record-breaking daily winter precipitation sum** of 46.8 mm thereby besting the previous record of 41.4 mm set on December 10, 1992.

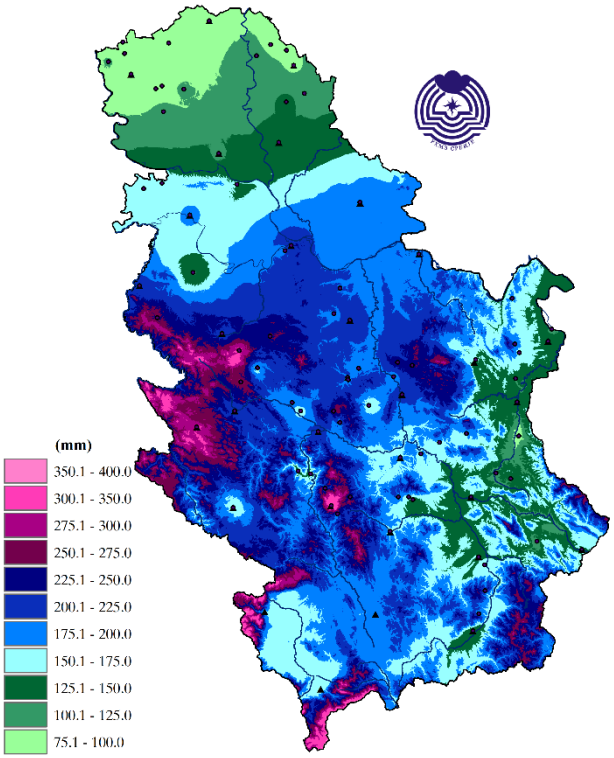


Figure 14. Spatial distribution of winter precipitation sums based on data from 28 major meteorological, 10 climatological and 48 rain gauge stations

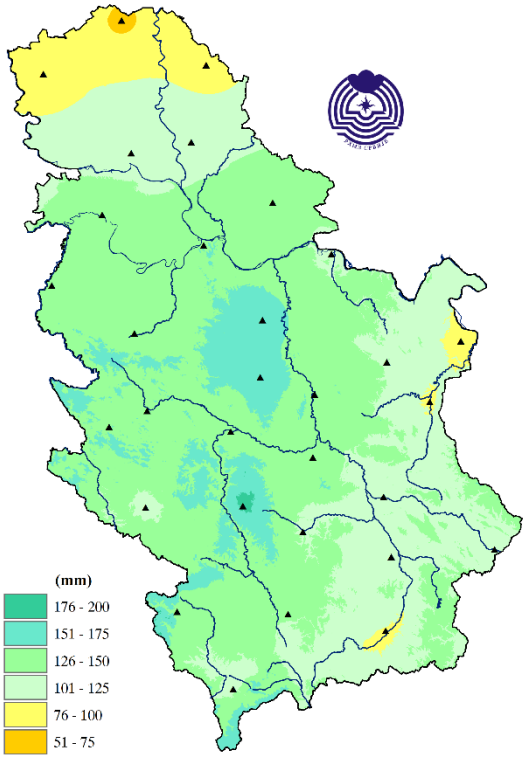


Figure 15. Spatial distribution of winter precipitation sums in percentage of normal

Based on percentile method, winter precipitation sums were in the following categories: very rainy and rainy in central, western, southwestern and northeastern parts of Serbia, elsewhere it was normal (*Figure 16)*, extremely rainy was in Pozega and Kopaonik, and dry on Palic.

Based on the tercile method, precipitation sums in central, western and northeastern parts of Serbia were in the rainy category, in northernmost areas in the dry category, elsewhere they were in the normal category (*Figure 17*).

Number of days with precipitation of 0.1 mm and above, ranged from 27 days in Sombor to 53 in Cuprija, and on the mountains from 47 at Crni Vrh to 54 at Zlatibor. The recorded number of days with precipitation was 2 to 9 days above the average in most of Serbia (*Figure 18*). Krusevac and Kopaonik recorded 3 days with precipitation sums above 20 mm and above.

Number of days with snow cover in the lowland of Serbia ranged from 1 in Negotin to 47 days in Pozega. In the hilly-mountainous regions, their number ranged from 73 days at Crni Vrh to 90 days at Kopaonik. Number of days with snow cover was below the average in most of Serbia, from 3 days in Kursumlija to 33 days in Zajecar (*Figure 19*).

On February 9 and 19, Kopaonik observed the maximum snow depth of 127 cm.

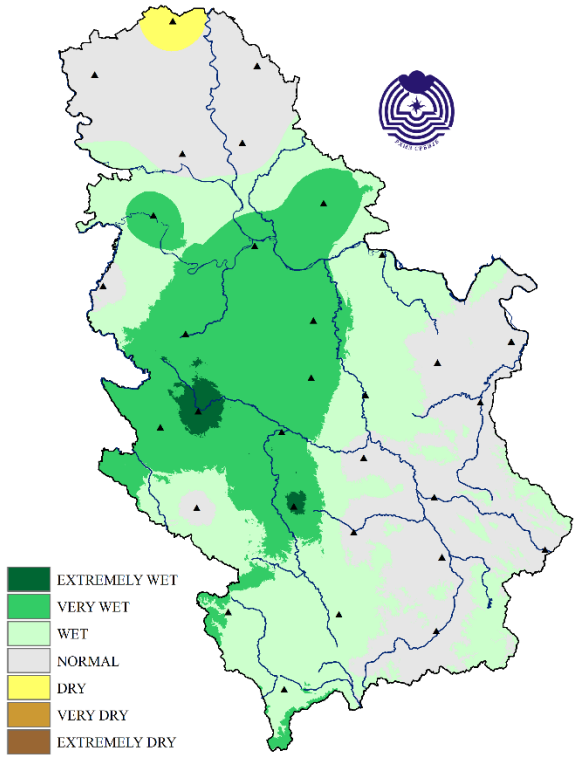


Figure 16. Winter precipitation sums according to the percentile method

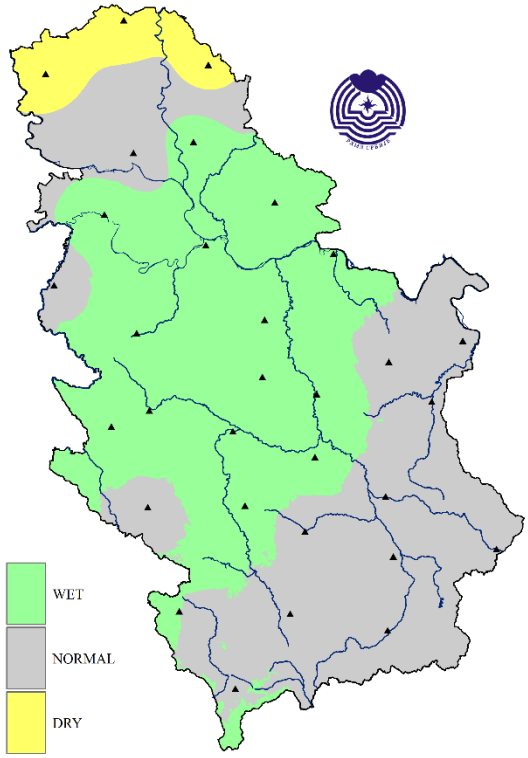


Figure 17. Winter precipitation sums according to the tercile method

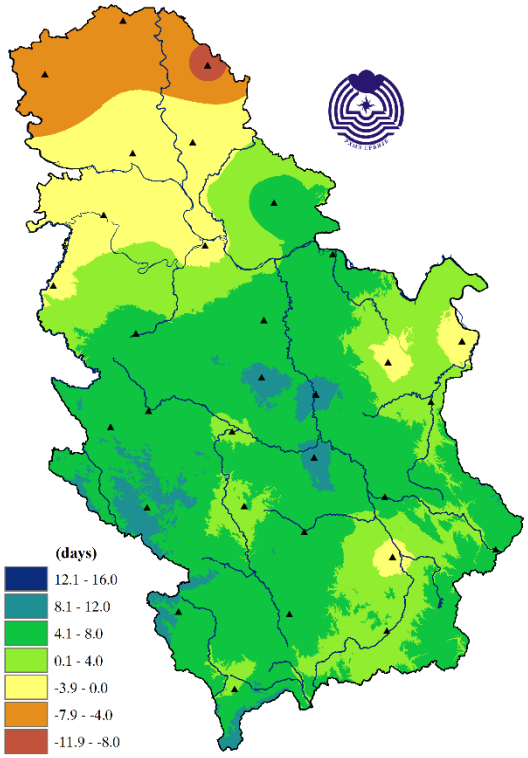


Figure 18. Deviation of number of days with precipitation of 0.1 mm and more from the normal

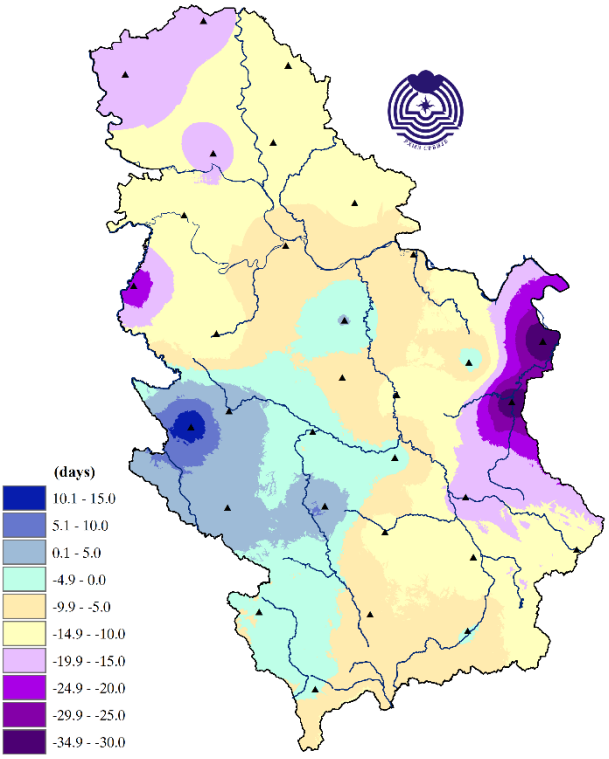


Figure 19. Deviation of number of days with snow cover from the normal

Sunshine duration (insolation)

Winter insolation ranged from 182.0 hours at Crni Vrh to 364.7 hours in Negotin (*Figure 20*).

Relative to the normal for the 1991-2020 base period, sunshine duration ranged from 72% at Crni Vrh to 154% in Sremska Mitrovica (*Figure 21*).

Palic observed new winter insolation record of 337.7 hours thereby breaking the previous record of 328.7 hours set in 1974/75.

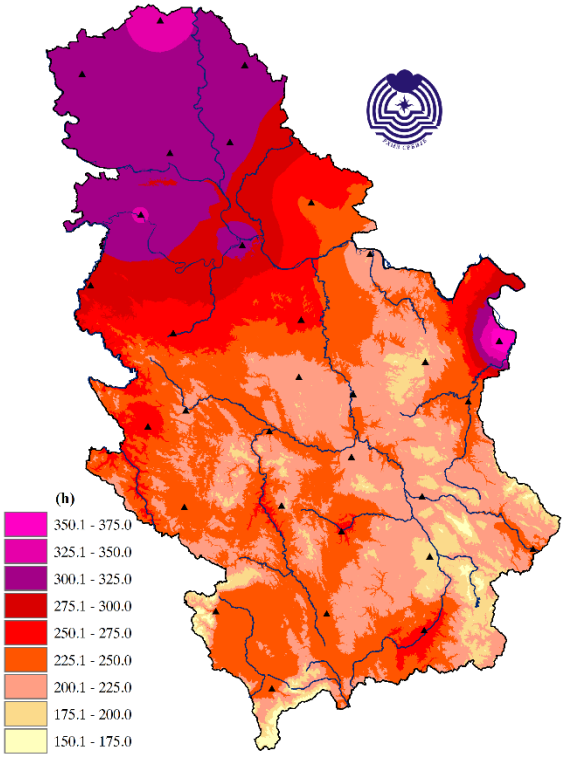


Figure 20. Insolation in hours

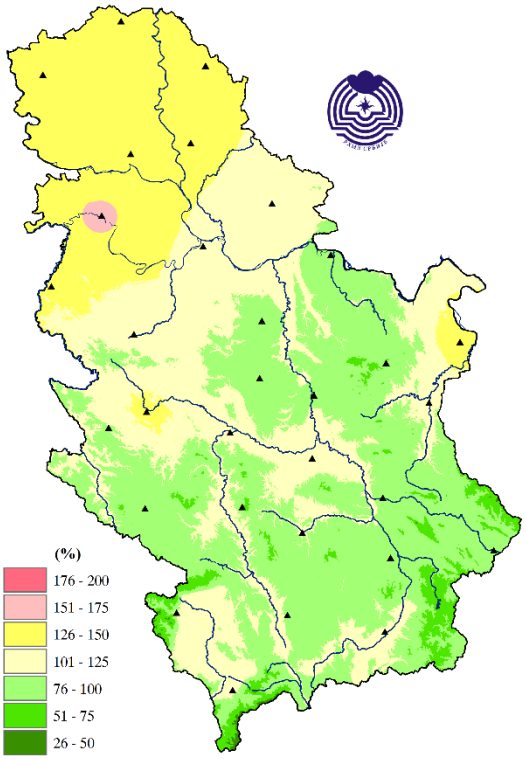


Figure 21. Insolation in percentage of normal

Analysis of the winter season 2021/22 for Serbia relative to the 1961-1990 base period

Temperature

Departure of the mean air temperature from the normal for the 1961-1990 base period ranged from 1.5ºC in Vranje to 3.9ºC in Negotin, and on the mountains from 0.5ºC at Kopaonik to 1.7ºC at Crni Vrh (*Figure 22*).

Based on the percentile method, mean air temperature in most of Serbia was in the categories of warm and very warm, whilst in the northern and certain eastern and western parts of the country it was extremely warm (*Figure 23*).

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

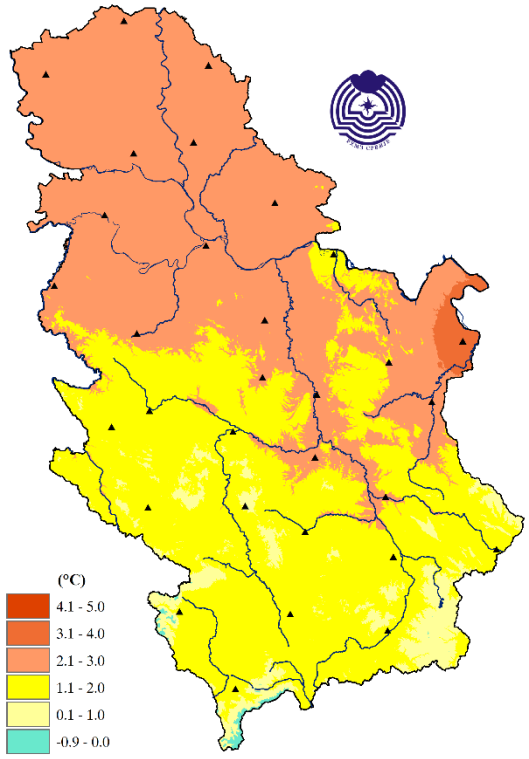


Figure 22. Spatial distribution of mean winter air temperature anomaly from the 1961-1990 normal

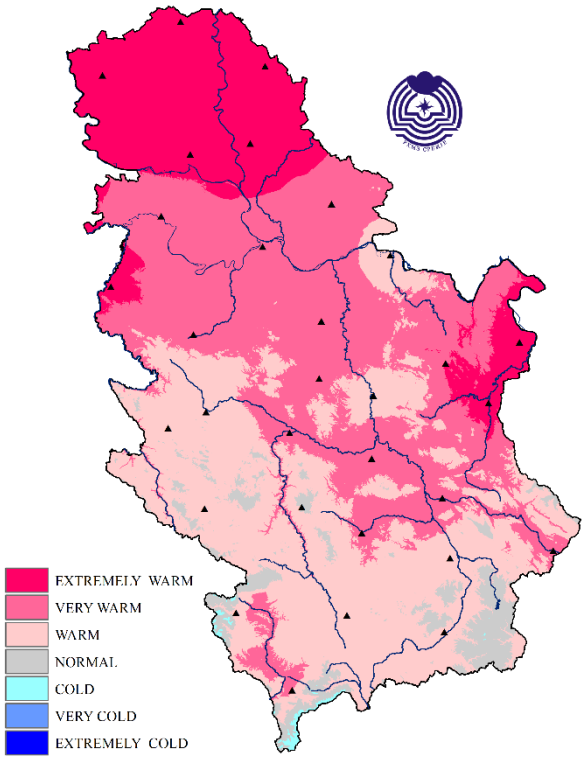


Figure 23. Spatial distribution of mean winter air temperature according to the percentile method

Precipitation

In most of Serbia, winter precipitation totals were within the average relative to the normal for the 1961-1990 base period. Precipitation sums expressed in the percentages of normal ranged from 72% on Palic to 161% in Kragujevac and Smederevska Palanka, and 187% on Kopaonik (*Figure 24*).

Based on the percentile method, winter precipitation sums were in the following categories: rainy and very rainy in most of Serbia, extremely rainy in Kragujevac, Smederevska Palanka and Kopaonik, and dry on Palic (*Figure 25*).

Based on the tercile method, precipitation sums were in the rainy category in most of Serbia and dry in parts of northern Serbia.

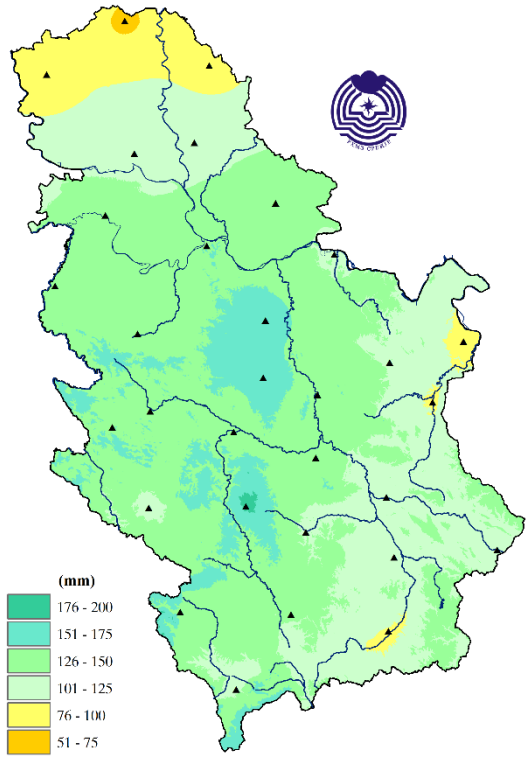


Figure 24. Spatial distribution of winter precipitation sums in percentage of the 1961-1990 normal

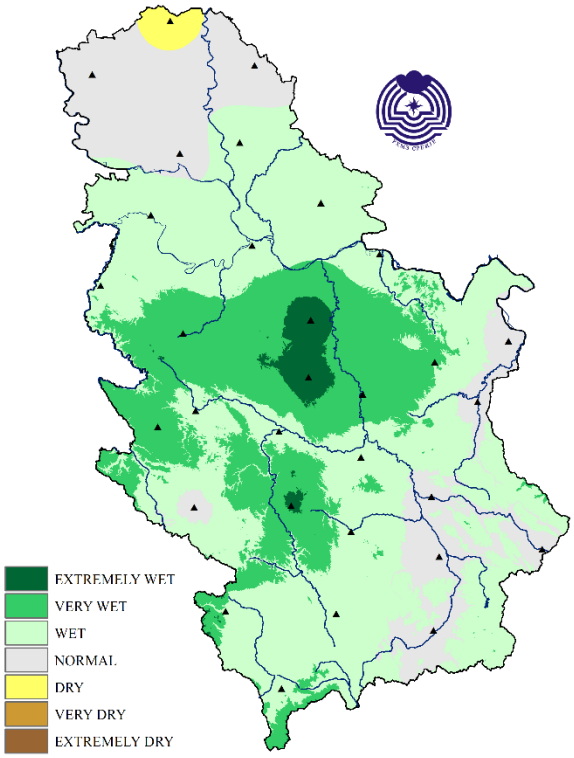


Figure 25. Winter precipitation sums according to the percentile method

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