VERIFICATION OF THE SEECOF–16 WINTER 2016/2017 CLIMATE OUTLOOK AND SEASONAL BULLETIN FOR THE TERRITORY OF SERBIA

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Temperature

According to the SEECOF-16 outlook for the winter 2016/2017 in Serbia, near- normal temperature was indicated in Serbia, relative to the 1981–2010 climatological base period (*Figure* 1).
Climatological monitoring showed that the winter of 2016/2017 was cold in almost entire Serbia with below-normal temperature based on the tercile method (*Figure* 2).
Hence, the outlook for a normal winter was not correct with the exception of the two meteorological stations in western Serbia where normal winter was indicated with 40% probability.

OUTLOOK – WINTER **2016/2017**

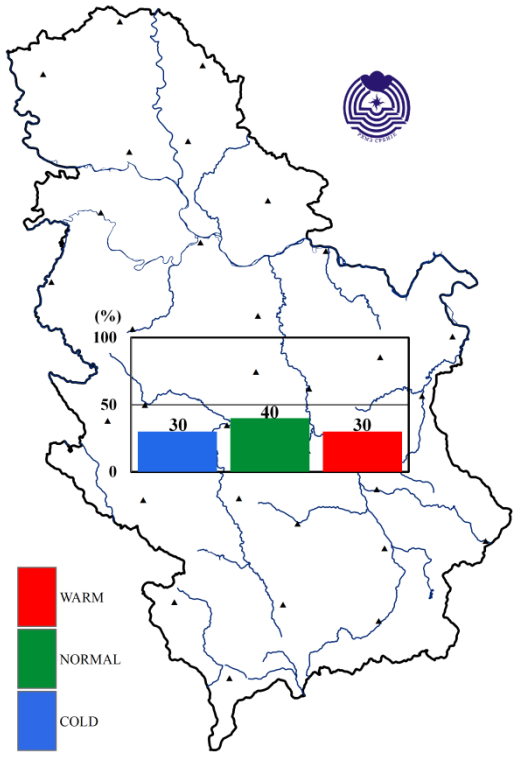

Figure 1. SEECOF-16 - winter temperature outlook

MONITORING – WINTER **2016/2017**

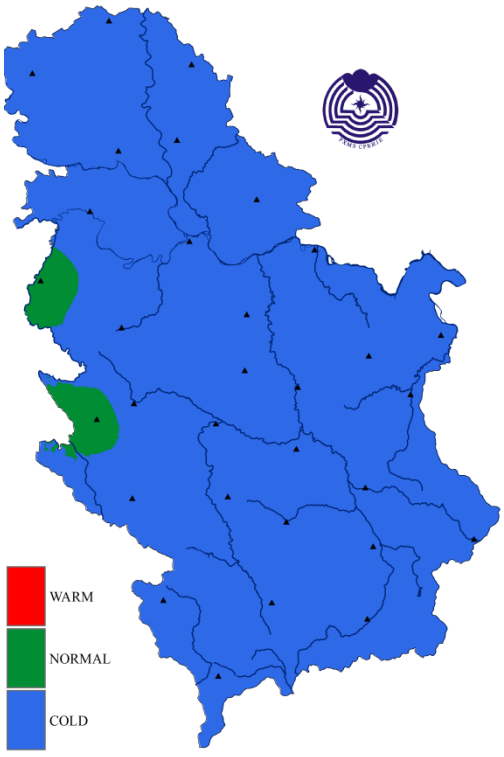

Figure 2. Monitoring of the winter temperature based on tercile method relative to the 1981-2010 base period

Note: Climatological analysis of meteorological elements was performed on the basis of the data obtained from 28 main meteorological stations. Apart from the data for the detailed analysis for precipitation, data from 22 climatological and 91 precipitation stations were used.

Precipitation

The SEECOF–16 climate outlook for the winter 2016/2017 in Serbia indicated approximately equal probabilities for below, near and above-average conditions (*Figure* 3).
Monitoring of precipitation showed dry winter conditions in entire Serbia (*Figure* 4).

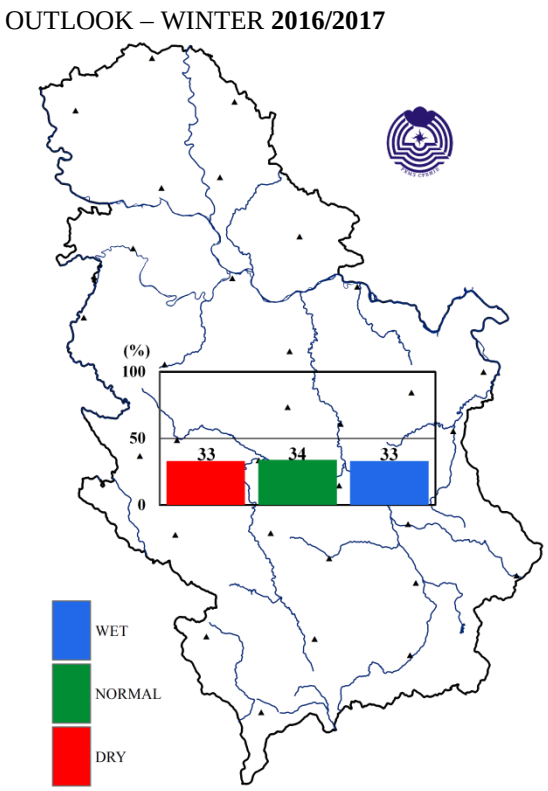

Figure 3. SEECOF-16 - winter precipitation outlook

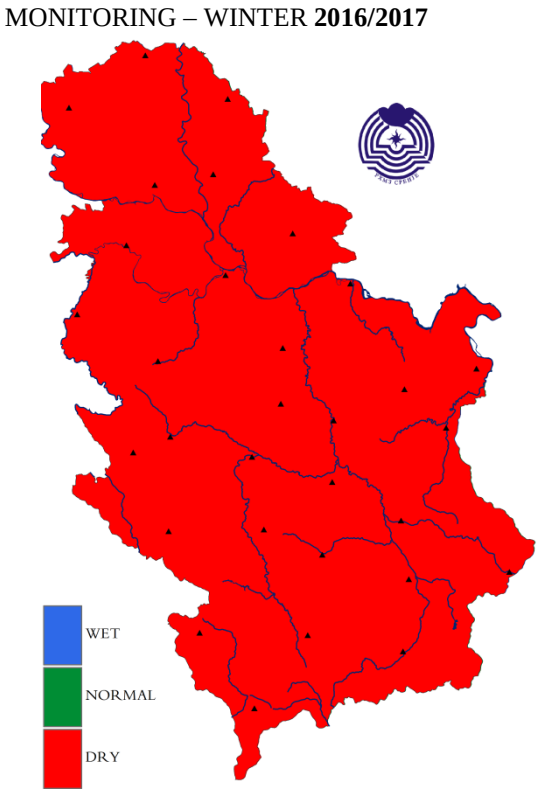

Figure 4. Monitoring of the winter precipitation based on the tercile method relative to the 1981-2010 base period

Winter 2016/2017			Air Temperature (°C)			
Station	Rank*	Rank**	33	50	66	Observed value
Beograd (1888-2017)	46	9	1.5	2.4	3.0	1.0
Palić (1946-2017)	17	8	-0.1	0.5	1.5	-0.7
Sombor (1942-2017)	14	6	0.0	0.9	1.8	-0.8
Novi Sad (1949-2017)	16	9	0.4	1.1	1.8	-0.3
Zrenjanin (1944-2017)	19	9	0.3	1.0	1.8	-0.2
Kikinda (1949-2017)	18	10	0.1	0.9	1.7	-0.4
Banatski Karlovac (1986-2017)	4	4	0.7	1.4	2.0	-0.3
Loznica (1953-2017)	20	12	0.7	1.8	2.5	0.8
Sremska Mitrovica (1926-2017)	15	4	0.4	0.9	1.6	-0.6
Valjevo (1927-2017)	18	7	0.7	1.3	2.2	0.2
Kragujevac (1926-2017)	13	4	0.9	1.5	2.3	0.0
Smederevska Palanka (1940-2017)	15	7	0.7	1.5	2.1	0.0
Veliko Gradište (1927-2017)	17	7	0.4	1.0	1.6	-0.5
Crni Vrh (1967-2017)	8	6	-3.6	-3.2	-2.1	-4.3
Negotin (1928-2017)	34	9	0.7	1.1	1.8	0.2
Zlatibor (1951-2017)	25	12	-2.2	-1.8	-0.8	-2.2
Sjenica (1947-2017)	23	10	-3.4	-2.5	-2.0	-4.1
Pozega (1953-2017)	16	9	-1.3	-0.7	0.3	-1.7
Kraljevo (1927-2017)	17	7	0.5	1.1	2.1	-0.2
Kopaonik (1950-2017)	18	11	-5.0	-4.6	-3.8	-5.0
Kursumlija (1953-2017)	13	9	0.3	1.0	1.5	-0.3
Krusevac (1931-2017)	14	6	0.7	1.1	1.9	-0.5

Cuprija (1949-2017)	12	7	0.4	1.2	1.7	-0.4
Nis (1926-2017)	16	7	1.1	1.6	2.3	0.0
Leskovac (1949-2017)	8	5	0.3	0.9	1.7	-1.1
Zajecar (1930-2017)	18	5	0.0	0.4	1.1	-0.8
Dimitrovgrad (1946-2017)	9	6	-0.5	0.0	1.1	-1.4
Vranje (1927-2017)	15	7	0.3	1.0	1.7	-0.5

*Rank –period of stations work (coldest season)
**Rank – 1981-2017 period (coldest season)

Winter 2016/2017			Precipitation sums (mm)			
Station	Rank*	Rank**	33	50	66	Observed Value
Beograd (1888-2017)	4	2	129.8	152.3	158.3	49.7
Palić (1945-2017)	4	2	90.1	104.4	121.5	45
Sombor (1942-2017)	9	4	104.2	114.8	123.0	69.7
Novi Sad (1948-2017)	3	2	109.9	119.1	133.5	38.2
Zrenjanin (1946-2017)	1	1	106.5	115.7	127.0	27.4
Kikinda (1948-2017)	1	1	98.0	105.5	121.2	24.9
Banatski Karlovac (1946-2017)	3	2	108.3	122.7	132.5	38.6
Loznica (1926-2017)	21	9	166.4	171.6	201.4	128
Sremska Mitrovica (1925-2017)	1	1	103.0	115.9	130.1	36.5
Valjevo (1926-2017)	8	3	149.5	157.6	173.3	95.3
Kragujevac (1925-2017)	6	4	113.0	120.0	134.0	58.6
Smederevska Palanka (1939-2017)	4	3	121.8	132.7	157.6	59.8
Veliko Gradište (1926-2017)	6	3	120.8	147.9	161.3	61.5

Crni Vrh (1967-2017)	4	3	127.6	143.8	170.7	79.6
Negotin (1927-2016)	6	5	105.9	137.3	186.9	63.3
Zlatibor (1950-2017)	6	4	204.3	225.1	237.8	114
Sjenica (1946-2017)	16	5	140.9	151.4	177.6	94.7
Pozega (1952-2017)	4	4	124.3	147.5	157.6	59.8
Kraljevo (1926-2017)	3	2	126.9	137.3	156.8	66.8
Kopaonik (1950-2017)	9	4	158.1	204.0	232.1	124
Kursumlija (1952-2017)	3	2	123.5	150.9	174.5	61.9
Krusevac (1927-2017)	2	2	115.1	133.2	155.6	53.9
Cuprija (1948-2017)	6	4	127.5	148.1	163.1	74.6
Nis (1925-2017)	5	4	117.7	137.1	150.6	59.3
Leskovac (1948-2017)	18	7	127.3	150.4	161.8	94.6
Zajecar (1929-2017)	5	4	103.7	136.3	146.6	61.9
Dimitrovgrad (1945-2017)	20	9	111.6	120.4	143.9	90.3
Vranje (1926-2017)	16	8	111.7	126.9	137.1	86.9

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

**Rank – 1981-2017 period (lowest seasonal precipitation)

Country	Seasonal temperature DJF		Seasonal precipitation DJF		High Impact Events
	Observed	SEECOF-16 climate outlook for temperature	Observed	SEECOF-16 climate outlook for precipitation	
Serbia (1)	Below normal in almost entire Serbia	**Near-normal** (30, 40, 30) in entire Serbia	Below normal in entire Serbia	**No predictive signal** (33, 34, 33) in entire Serbia	* **Winter of 2016/2017** was the fourth driest and 12th coldest for Serbia * 4 cold waves; the longest during first half of January in almost entire Serbia * The number of ice and frost days and days with severe frost was surpassed * **Cold and extremely dry December**; driest on record on two stations; rainfall was not registered on one station; fourth driest in Serbia * **January 2017 was the fourth coldest for Serbia and the coldest on record for two stations;** number of ice days was surpassed at three stations; number of frost days and days with snow cover was exceeded at most meteorological stations * At Kopaonik mountain lowest daily minimum air temperature on record was observed * Three cold waves; during the first cold wave, daily minimum air temperature difference from the mean daily minimum air temperature reached -20.4°C

Winter of 2016/17 was the fourth driest and 12th coldest for Serbia. There were 4 cold waves recorded. The number of ice and frost days as well as days with severe frost was surpassed.

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

Temperature

Mean winter air temperature ranged from -1.7ºC in Pozega to 1.0ºC in Belgrade, and in the mountain regions from -5,0ºC at Kopaonik to -2,2ºC on Zlatibor (Figure 1).

During winter, departure of the mean air temperature from the normal[1], ranged from od -2.0ºC in Leskovac to -1.0ºC in Belgrade and Loznica, and on the mountains from -1.4ºC on Crni Vrh to -0.7ºC on Zlatibor and Kopaonik (Figure 2).

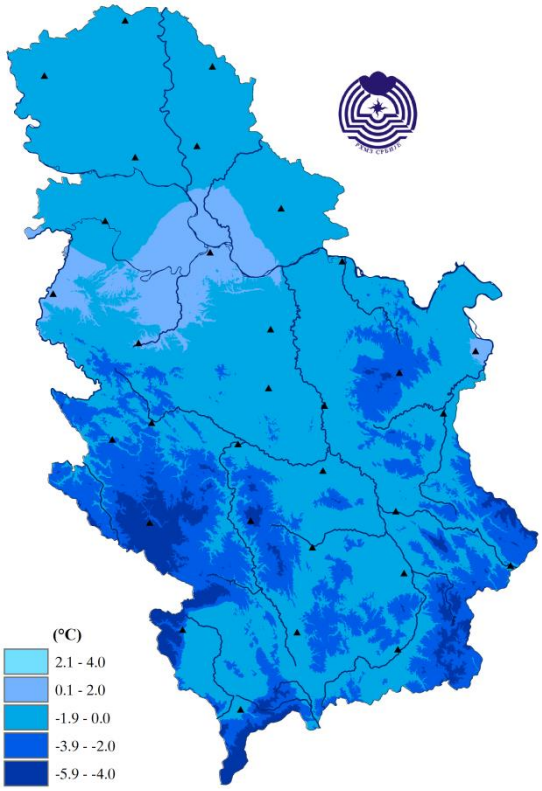

Figure 1. Mean seasonal air temperature during winter 2016/17 expressed in (°C)

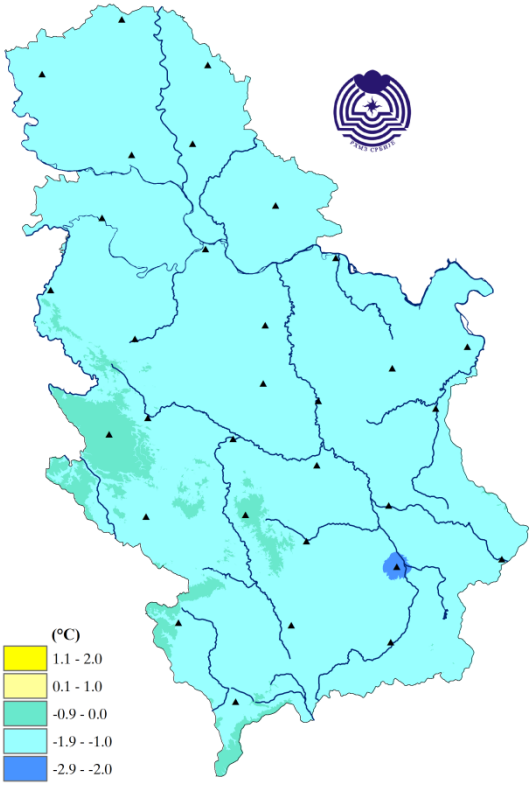

Figure 2. Departure of the mean seasonal air temperature relative to the 1981-2010 base period

Based on the percentile method[2], mean winter air temperature was in the cold category across most of Serbia, very cold in Kragujevac, and normal category in parts of the northern and western Serbia as well as Kopaonik (Figure 3).

[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 tercile method, mean winter air temperature was in the cold category across most of Serbia apart from Loznica and Zlatibor where it was in the normal category (Figure 4).

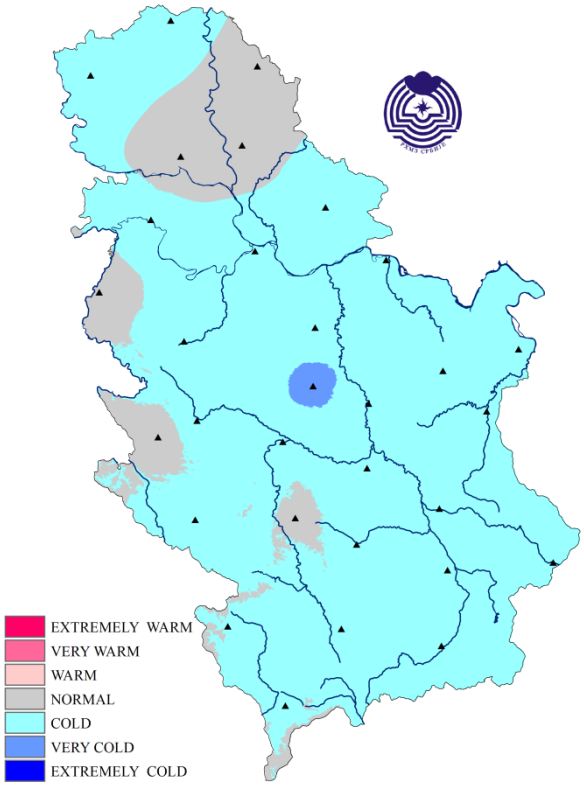

Figure **3.** Mean seasonal air temperature based on percentile method

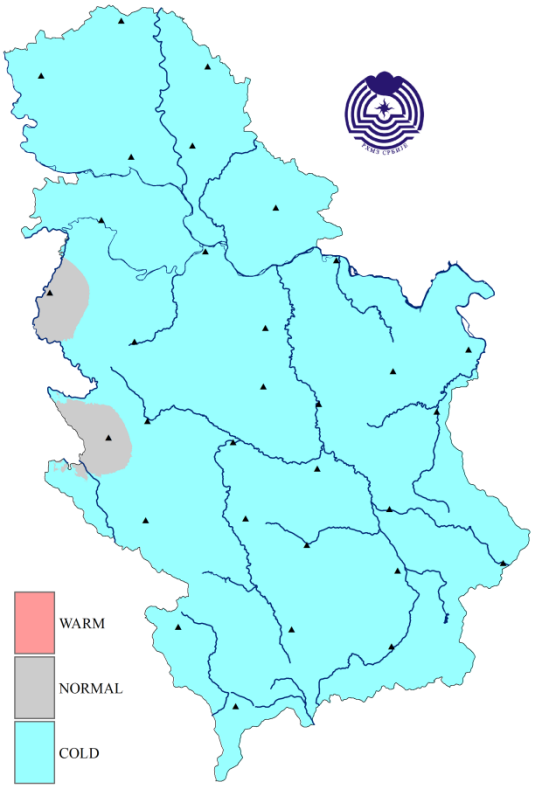

Figure 4. Mean seasonal air temperature based on tercile method

Winter of 2016/17 was the **12th coldest for Serbia and 8th coldest for Crni Vrh and Leskovac** (Figure 5 and 6).

[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

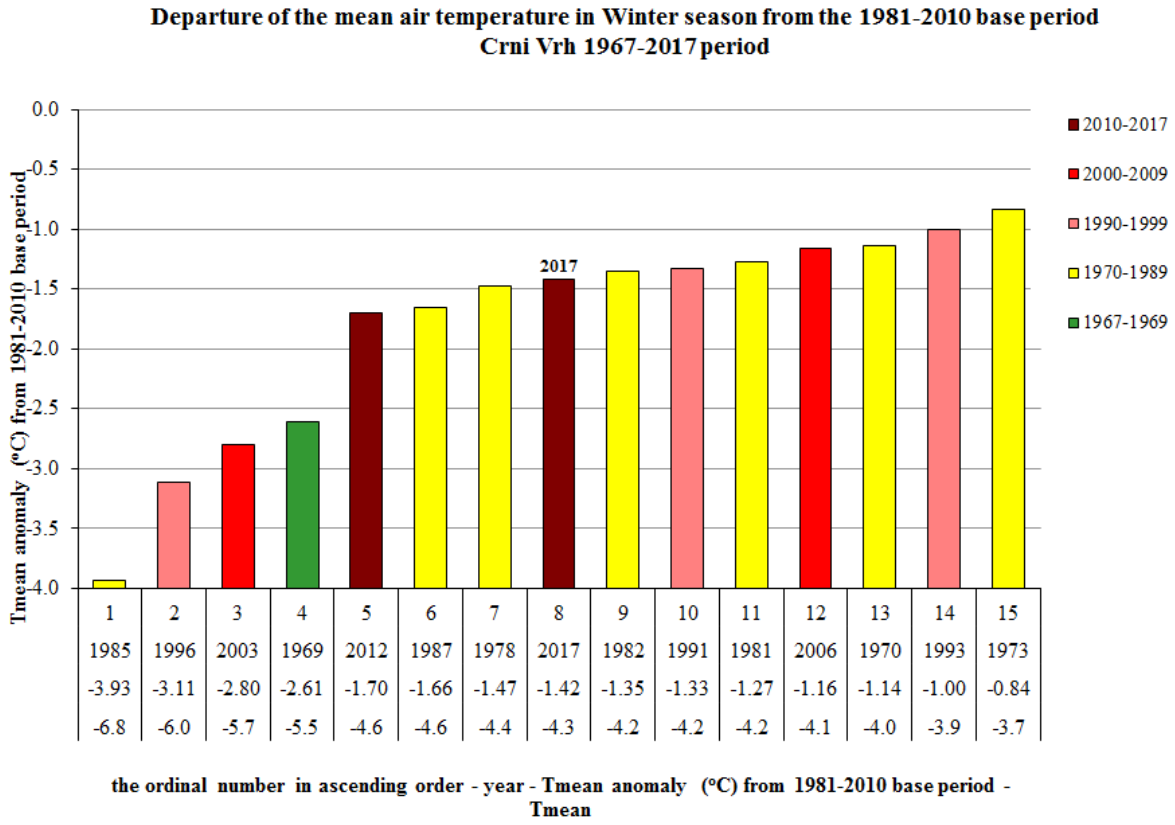

Figure 5. Rank of the coldest winter seasons for Crni Vrh in the period from 1967 to 2017

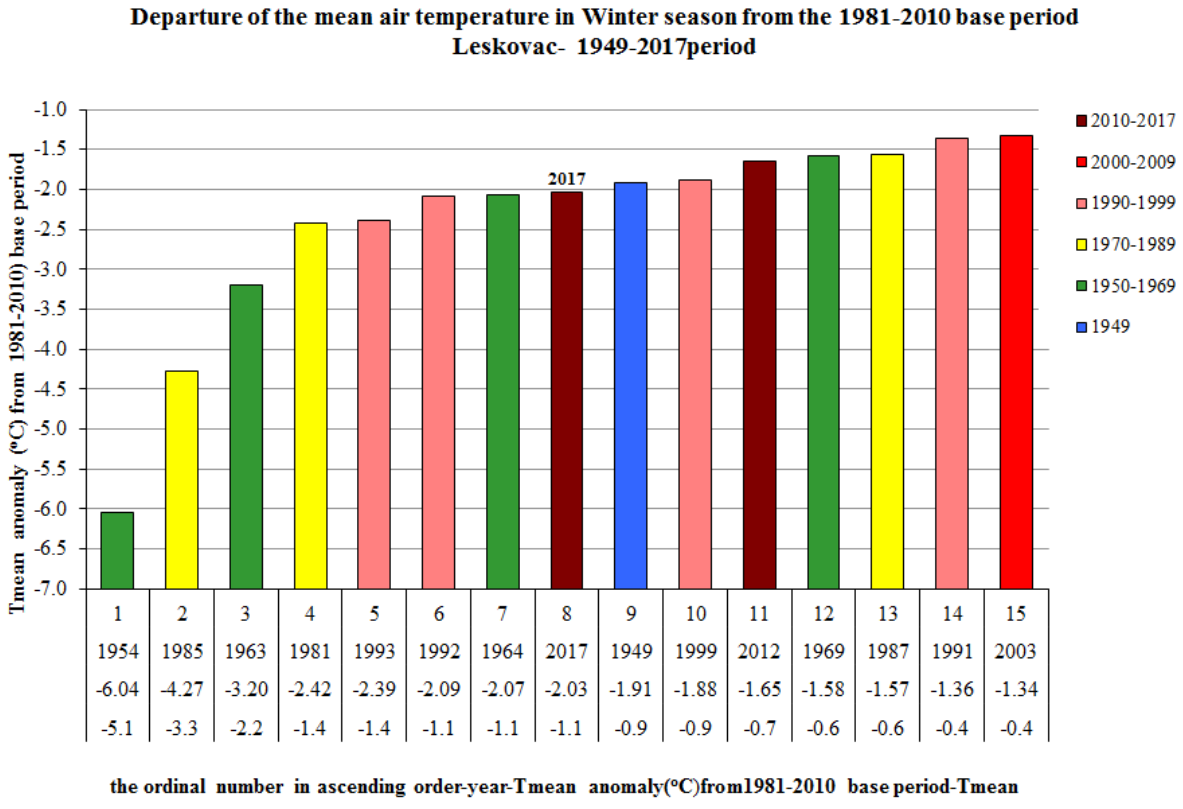

Figure 6. Rank of the coldest winter seasons for Leskovac in the period from 1949 to 2017

The number of ice days with the maximum daily air temperature below 0ºC, ranged from 15 in Vranje to 29 days in Sremska Mitrovica, and on the mountains from 30 ice days on Zlatibor to 57 days on Crni Vrh. The recorded number of ice days was 1 to 13 days above the average, and on Kopaonik, 4 days below the average (Figure 7).

The lowest winter air temperature of -27.6ºC was measured in Sjenica on January 8.

The number of frost days, with the minimum daily air temperature below 0ºC ranged from 65 days in Loznica to 81 day in Pozega, and on the mountains from 76 days on Zlatibor to 88 days at Kopaonik. The number of frost days was 2 to 18 days above the winter average (Figure 8).

The number of days with severe frost with the minimum daily air temperature below -10 ºC ranged from 7 days in Belgrade to 22 days in Dimitrovgrad, and in the highland from 14 days on Zlatibor to 38 days in Sjenica. The recorded number of days with severe frost in Serbia was 1 to 12 days above the winter average number of days with severe frost.

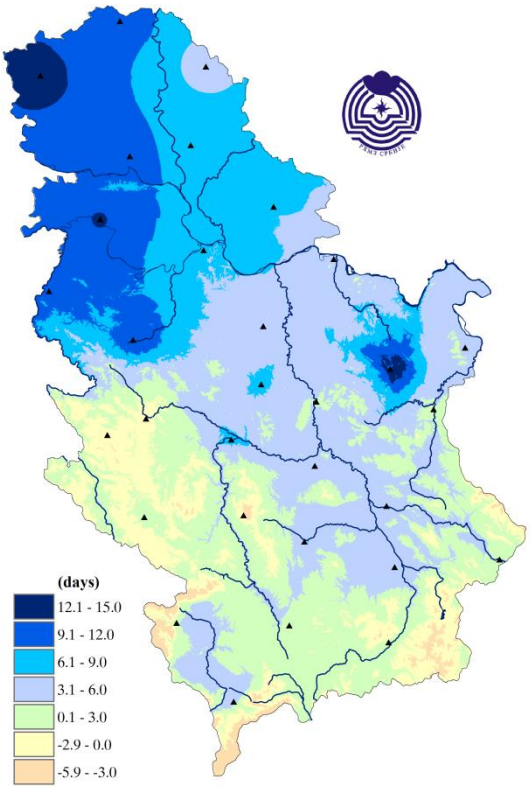

Figure 7. Deviation of the number of ice days relative to the 1981-2010 base period

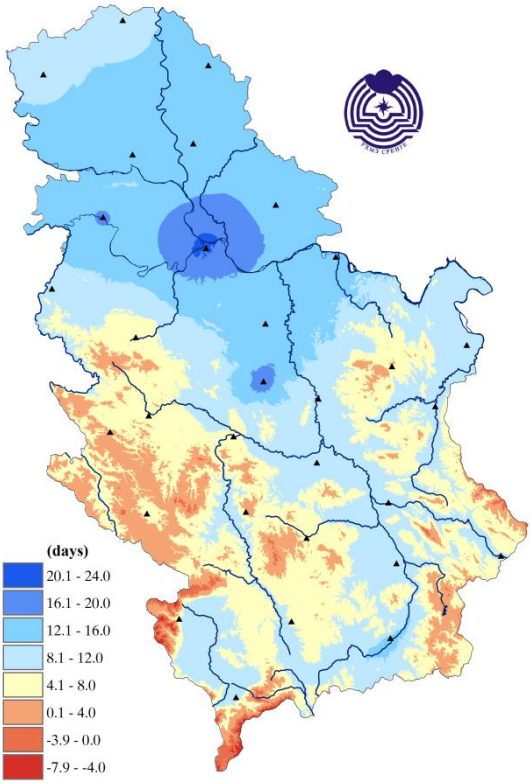

Figure 8. Deviation of the number of frost days relative to the 1981-2010 base period

In Belgrade, at the end of the first and at the beginning of the second decade of January, the mean, maximum and minimum air temperature was below the multiannual average, and above the average at the beginning, end of December and most of February (Figure 9).

Three-month course of the mean daily air temperature for Belgrade and Kopaonik during winter of 2016/17 is shown in Figures 10 and 11.

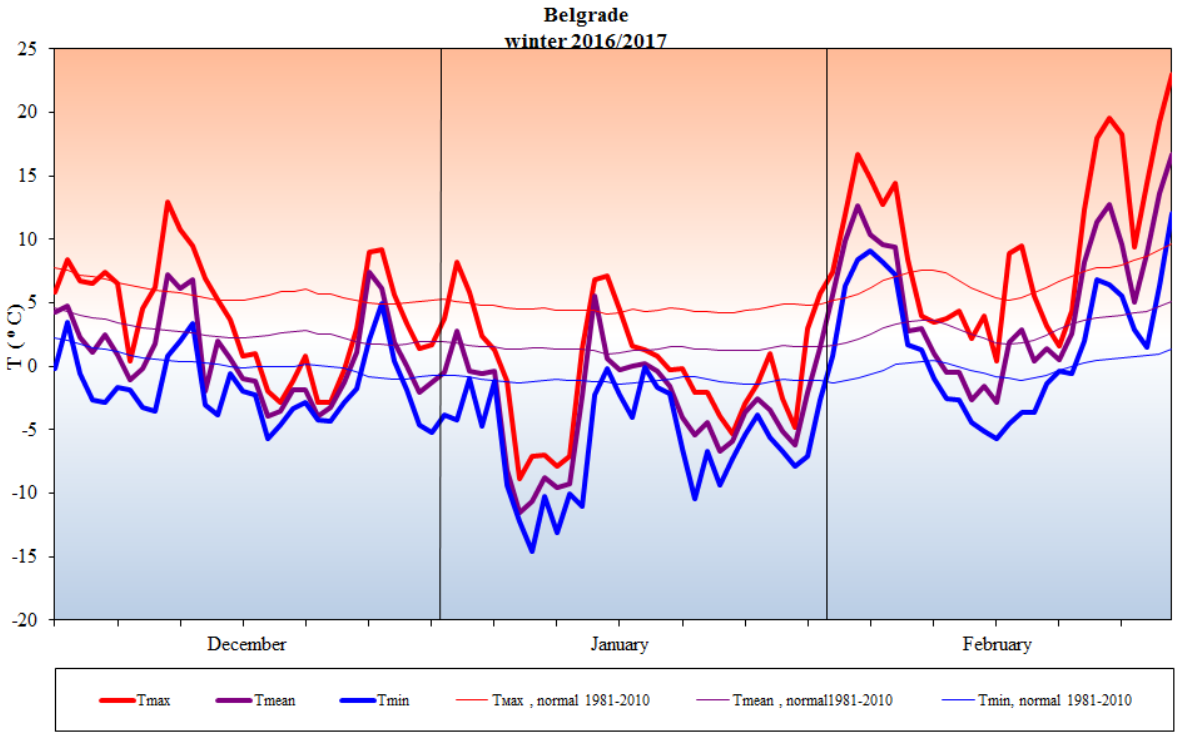

Figure 9. Three-month course of the mean, maximum and minimum air temperature for Belgrade

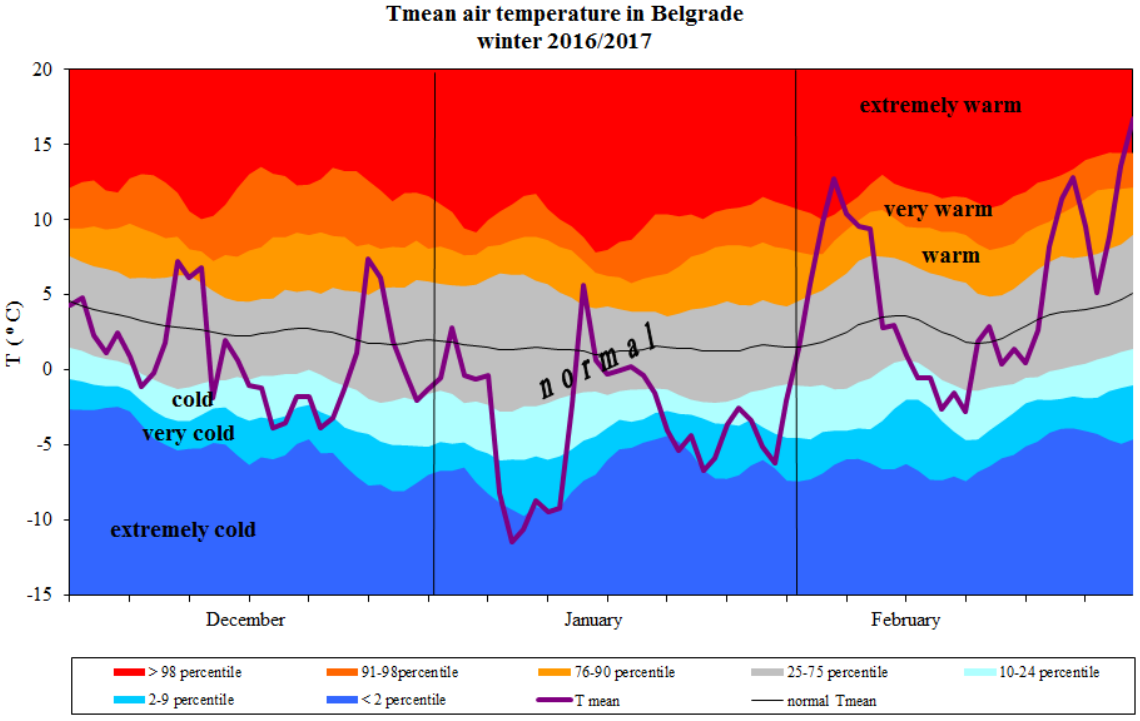

Figure 10. Three-month course of the daily mean air temperature for Belgrade

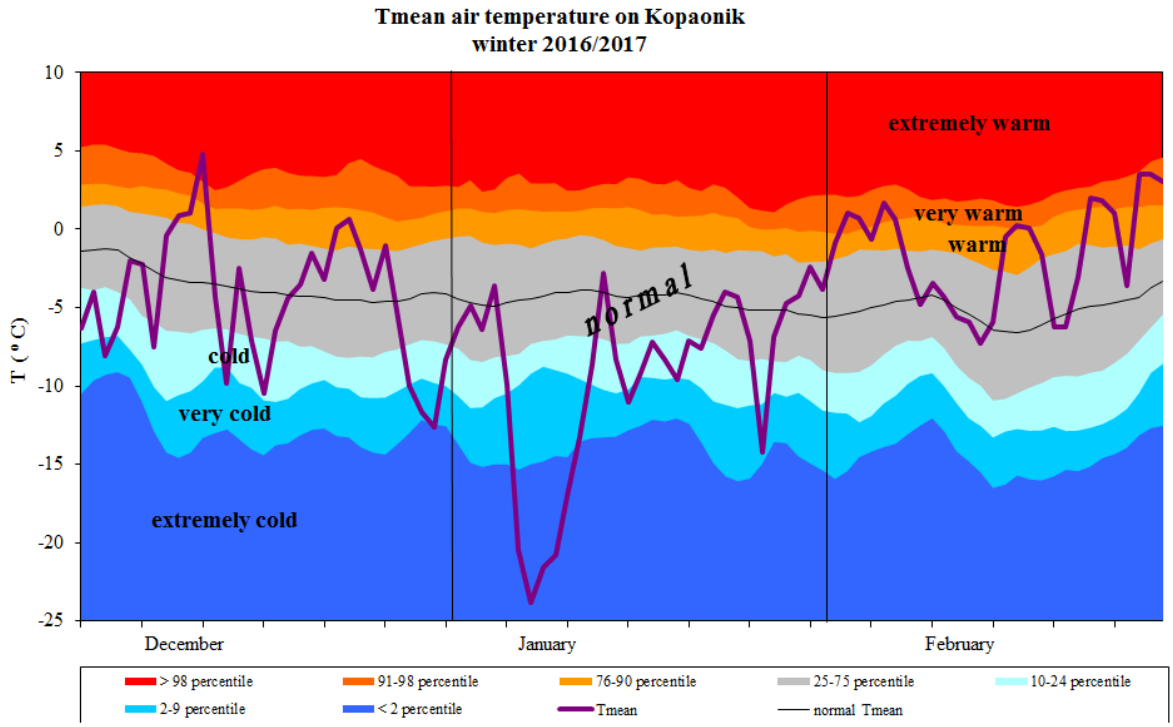

Figure 11. Three-month course of the daily mean air temperature at Kopaonik

Figure 12 shows assessment of the air temperature and precipitation sums in Serbia for the winter season based on the tercile distribution relative to the 1981-2010 base period. It can be noted that winter of 2016/17 was characterized by **air temperature and precipitation sums in the lower tercile.**

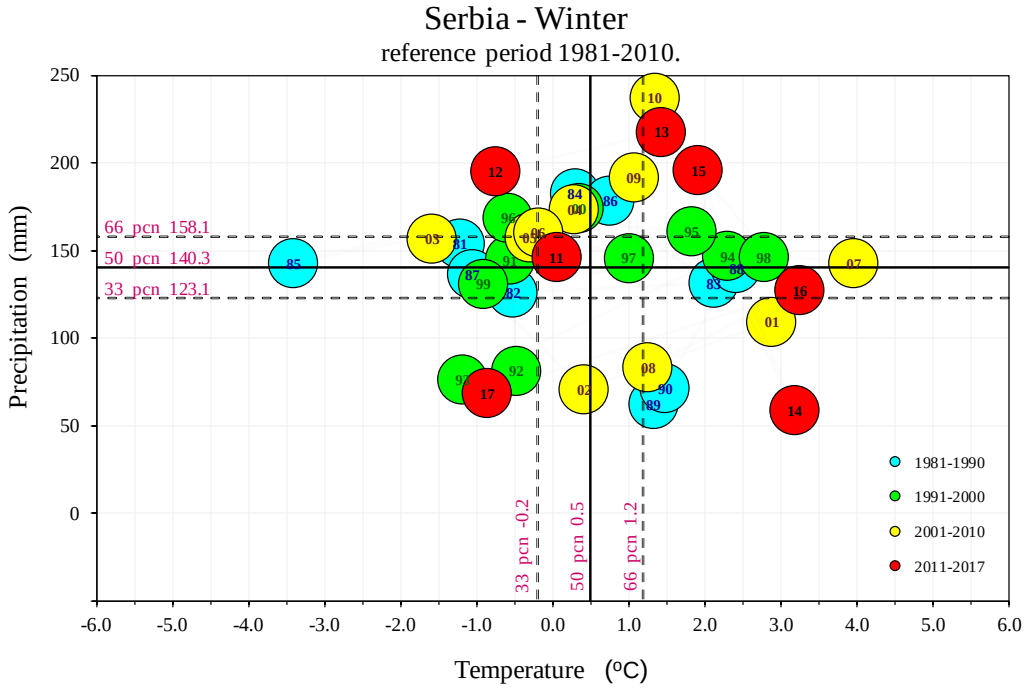

Figure 12. Assessment of the air temperature and winter precipitation sums based on the accompanying terciles relative to 1981-2010 base period

Cold waves during winter of 2016/2017

At the beginning of December, one cold wave[3] was observed at MMS Sombor, lasting from 4 to 8 December. Three cold waves were registered in January. The second most intense cold wave during this winter first encompassed Vojvodina and mountain regions on January 6, subsequently expanding to the entire country on January 7 with the duration until January 12, 2017. The third cold wave was recorded in the period from January 20 to 24, 2017 at seven main meteorological stations, whereas in Sremska Mitrovica it lasted from 19 to 24 January. The fourth cold wave was recorded in the period from 27 to 31 January 2017 in Pozega, Krusevac and Sjenica.

Table 1.

COLD WAVES IN SERBIA - WINTER 2016/2017

(compared to 1981-2010 base period)

DECEMBER

station / day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
PALIC																															
SOMBOR				VC	VC	VC	VC	VC																							
KIKINDA																															
ZRENJANIN																															
NOVI SAD																															
SR.MITROVICA																															
BEOGRAD																															
LOZNICA																															
VALJEVO																															
V.GRADISTE																															
SM.PALANKA																															
KRAGUJEVAC																															
KRALJEVO																															
POŽEGA																															
ZLATIBOR																															
CUPRIJA																															
KRUSEVAC																															
NEGOTIN																															
ZAJECAR																															
CRNI VRH																															
KOPAONIK																															
SJENICA																															
NIS																															
VRANJE																															
DIMITROVGRAD																															
LESKOVAC																															
KURSUMLIJA																															
B.KARLOVAC																															

JANUARY

station / day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
PALIC							VC	EC	VC	EC	VC	VC																			
SOMBOR						VC	VC	EC	VC	EC	VC	VC																			
KIKINDA						VC	VC	EC	VC	EC	VC	VC																			
ZRENJANIN							VC	EC	VC	EC	VC	VC																			
NOVI SAD						VC	EC	EC	EC	EC	VC	VC																			
SR.MITROVICA							VC	EC	EC	EC	EC	EC							VC	EC	EC	EC	VC								
BEOGRAD						VC	EC	EC	VC	EC	VC	VC								EC	EC	VC	EC	VC							
LOZNICA							VC	EC	VC	EC	VC	EC																			
VALJEVO							VC	EC	VC	EC	VC	EC	VC							VC	EC	EC	EC	VC							
V.GRADISTE																				EC	EC	VC	VC	VC							
SM.PALANKA							VC	EC	VC	EC	EC	EC																			
KRAGUJEVAC							VC	EC	VC	EC	VC	EC								EC	EC	EC	EC	VC							
KRALJEVO																															
POŽEGA							EC	EC	VC	EC	VC	EC	VC														VC	EC	EC	EC	VC
ZLATIBOR						VC	EC	EC	EC	EC	EC	EC																			
CUPRIJA																				VC	EC	EC	VC	VC							
KRUSEVAC							VC	EC	VC	EC	VC	EC	VC							EC	VC	EC	EC	VC			VC	EC	VC	VC	VC
NEGOTIN							VC	VC	VC	EC	VC	VC	VC																		
ZAJECAR							VC	VC	VC	VC	VC	EC																			
CRNI VRH						EC	EC	EC	EC	EC	VC	VC																			
KOPAONIK						EC	EC	EC	EC	EC	VC	VC																			
SJENICA							VC	EC	VC	EC	VC	EC															VC	VC	VC	VC	VC
NIS							VC	EC	VC	EC	VC	EC	VC																		
VRANJE							VC	EC	VC	VC	VC	EC	EC																		
DIMITROVGRAD							VC	VC	VC	EC	EC	EC	VC																		
LESKOVAC							VC	EC	VC	VC	VC	EC								VC	EC	EC	EC	EC							
KURSUMLIJA																															
B.KARLOVAC							VC	EC	EC	EC	VC	EC																			

FEBRUARY

station / day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
PALIC																												
SOMBOR																												
KIKINDA																												
ZRENJANIN																												
NOVI SAD																												
SR.MITROVICA																												
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B.KARLOVAC																												

Legend: VC – very cold EC – extremely cold

[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

Precipitation

Winter precipitation totals were below the average across most of Serbia relative to the normal for the 1981-2010 base period, ranging from 24.9 mm in Kikinda to 127.8 mm in Loznica (Figure 13). Precipitation sums relative to the normal ranged from 23% in Kikinda to 73% in Loznica and Dimitrovgrad (Figure 14).

Based on the percentile method, winter precipitation sums were in the following categories: extremely dry and very dry across most of Serbia, dry in Loznica, Negotin, Sjenica and southern Serbia, and normal in Loznica and Dimitrovgrad (Figure 15).

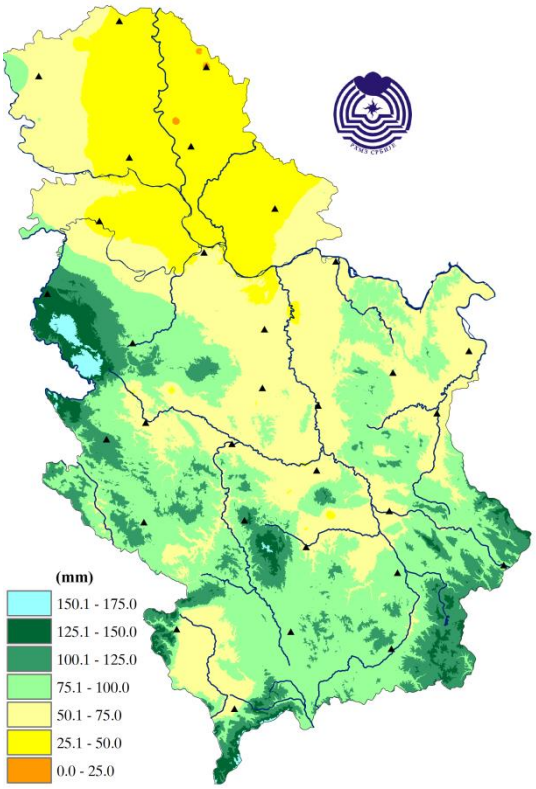

Figure 13. Spatial distribution of winter precipitation sums expressed in mm (data on precipitation obtained from 28 MMS and 2 CS and 91 PS)

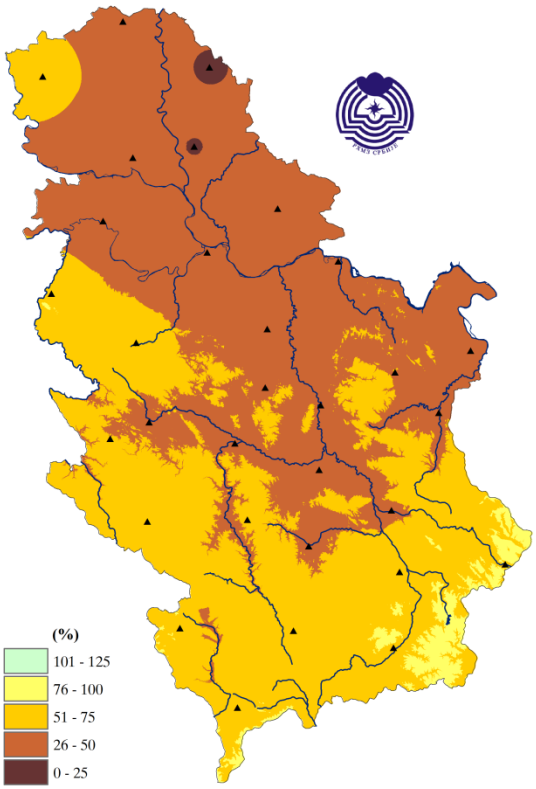

Figure 14. Spatial distribution of the winter precipitation sums expressed in % from normal 1981-2010

Precipitation sums based on the tercile method in Serbia were below the average (Figure 16).

The maximum daily precipitation sum of 32.6 mm was recorded in Loznica on February 25.

The number of days with precipitation of 1mm and above recorded during winter ranged from 20 days in Zajecar to 39 days at Crni Vrh. The recorded number of days with precipitation was from 7 to 16 days below the average (Figure 17).

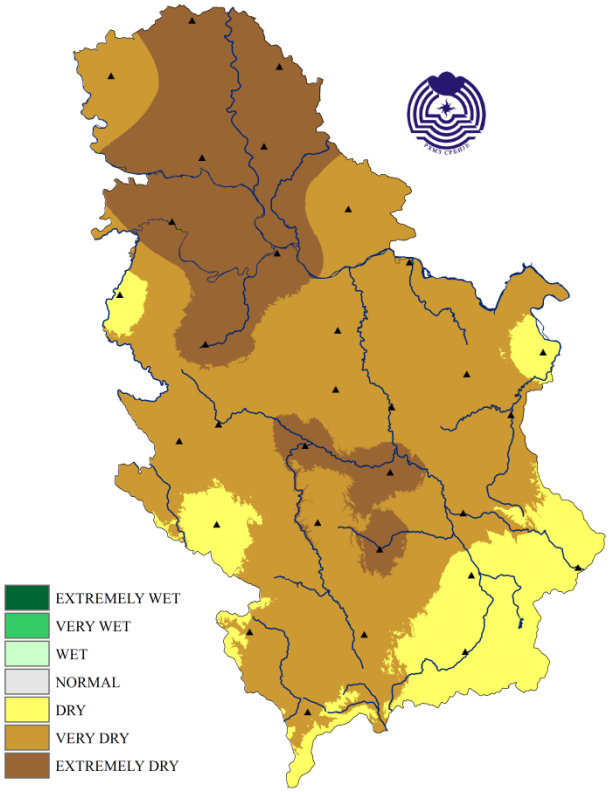

Figure 15. Precipitation sums based on percentile method

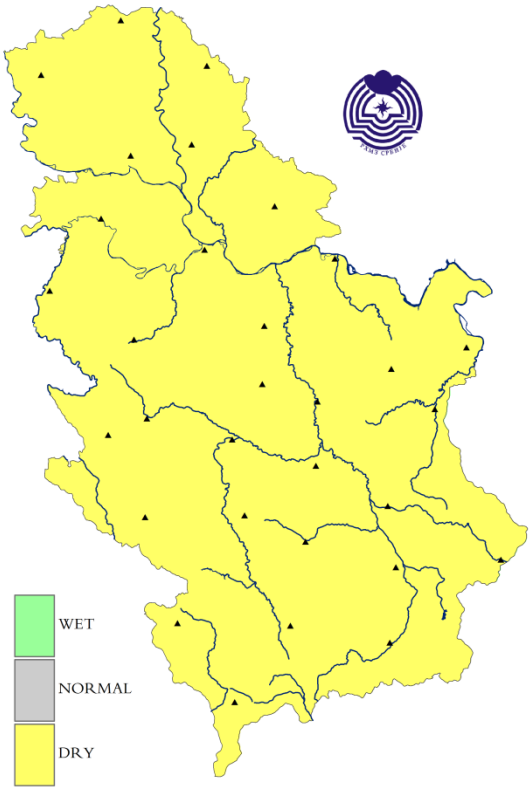

Figure 16. Precipitation sums based on tercile method

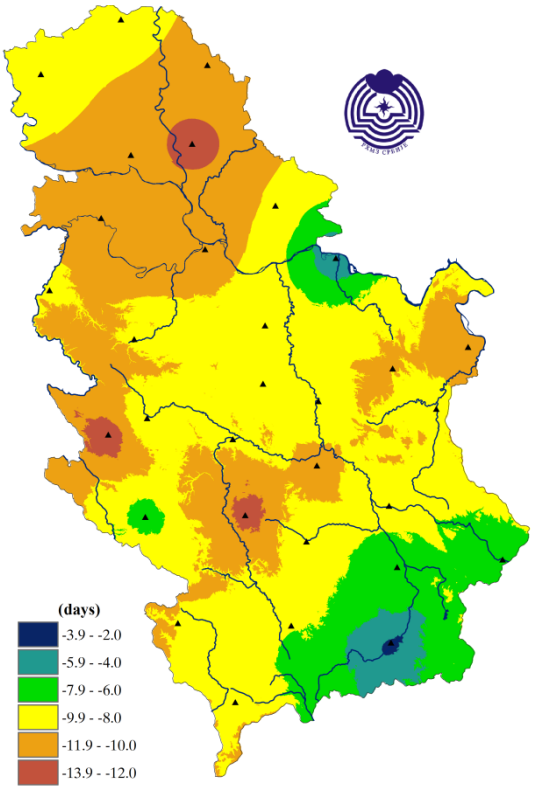

Figure 17. Deviation of the number of days with precipitation of 1.0mm and above

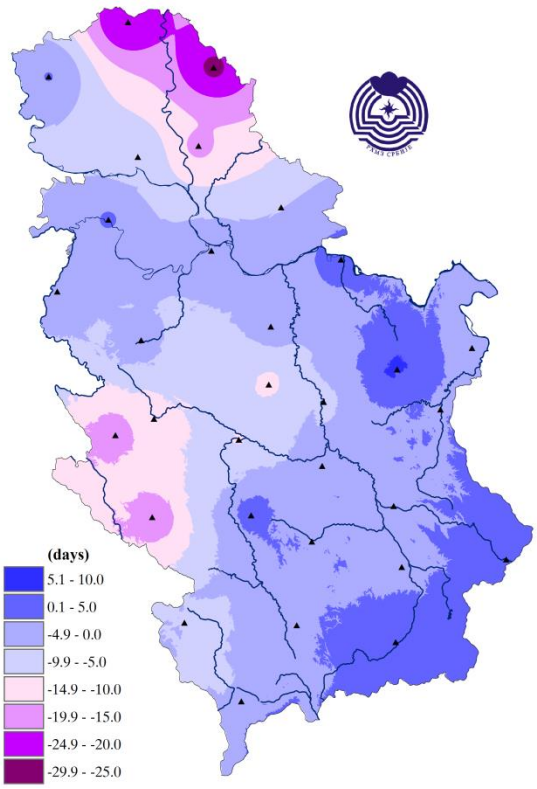

Figure 18. Deviation of the number of days with snow cover

The number of days with snow cover in the lowland of Serbia ranged from 4 in Kikinda to 44 in Dimitrovgrad. In the hilly-mountainous regions, the number of days with the snow cover ranged from 53 in Sjenica to 90 days at Kopaonik. The registered number of days with the snow cover was between 2 and 27 days below the winter average in most of the country (Figure 18). The maximum snow depth of 70cm was measured at Kopaonik on January 20.

Based on the analysis of the wettest and driest winter seasons in Serbia for the 1951-2017 period, it can be concluded that winter of 2016/17 was the **fourth driest winter** for Serbia (Figure 19).

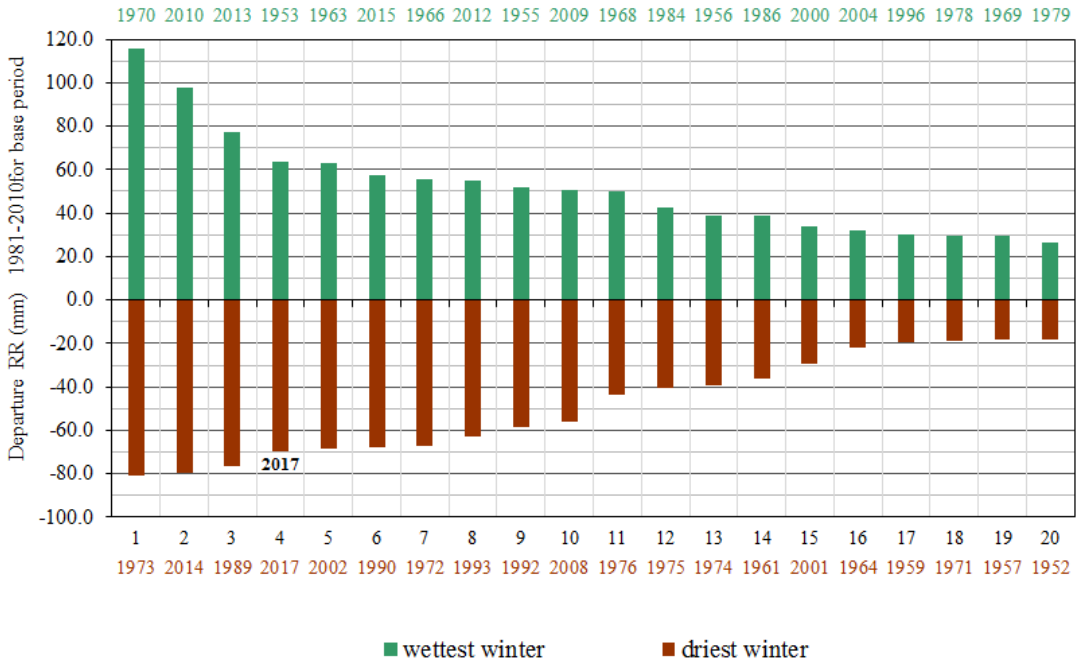

Figure 19. Rank of the wettest and driest winter seasons in Serbia for the 1951-2017 period relative to the 1981-2010 base period

Figures 20 and 21 show cumulative precipitation sums for Belgrade and Krusevac during winter per months relative to the average cumulative precipitation sums.

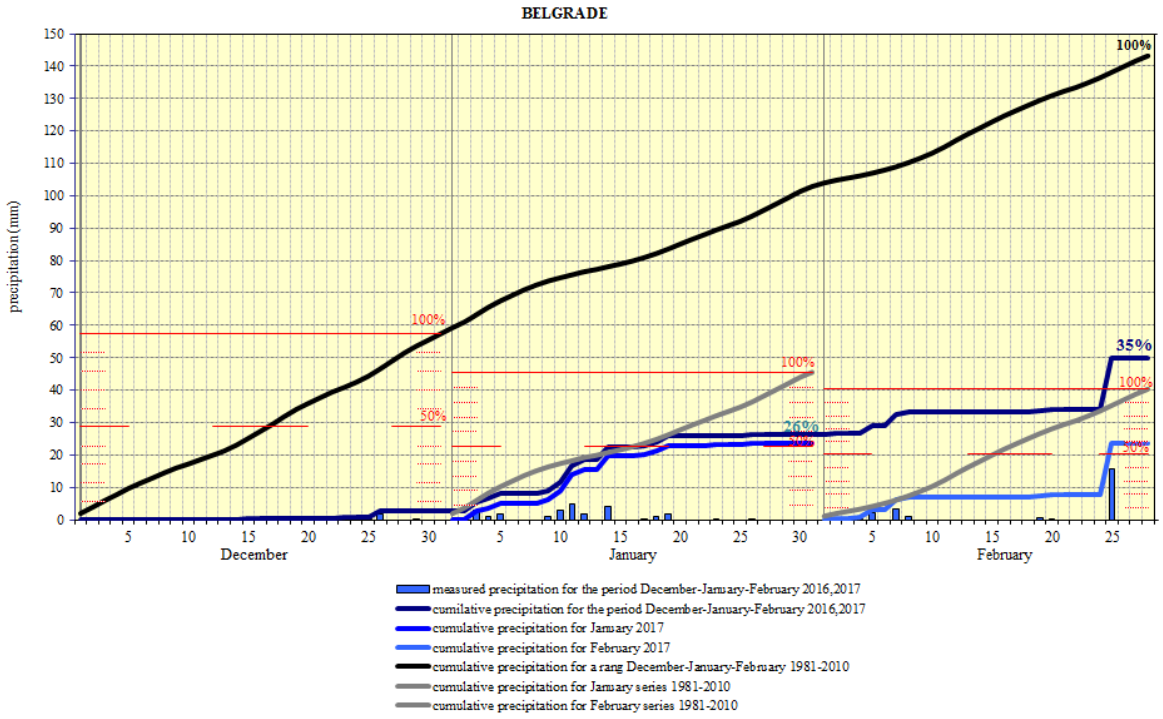

Figure 20. Cumulative precipitation sums for Belgrade

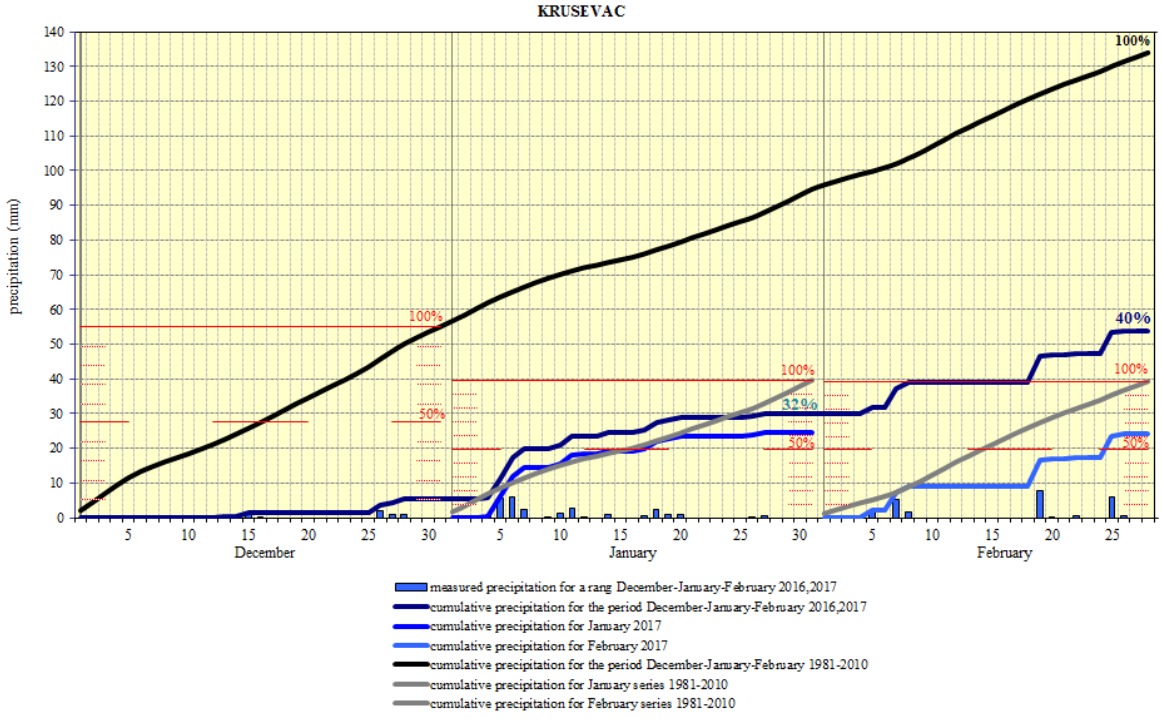

Figure 21. Cumulative precipitation sums for Krusevac

Sunshine duration (insolation)

Sunshine duration in winter ranged from 198.0 in Leskovac to 370.0 hours at Kopaonik (Figure 22).

Compared to the normal for the 1981-2010 base period, winter insolation ranged from 95% in Leskovac to 186% in Pozega (Figure 23).

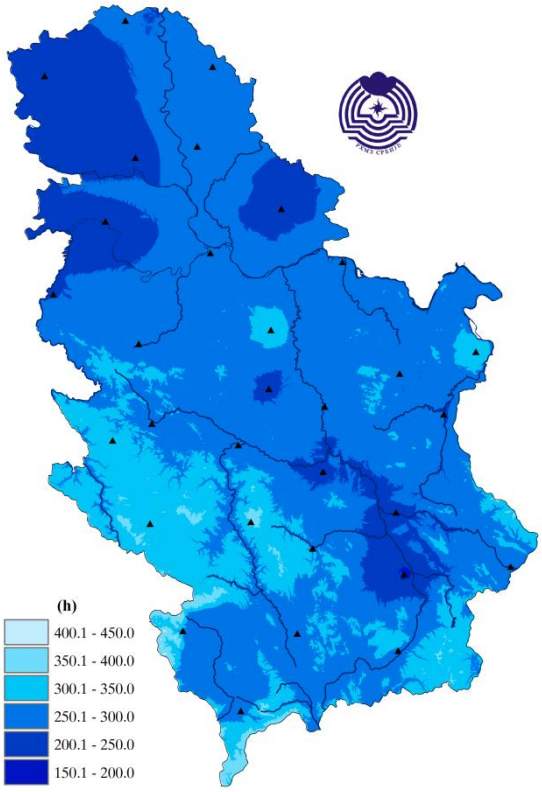

Figure 22. Insolation (hours) during autumn

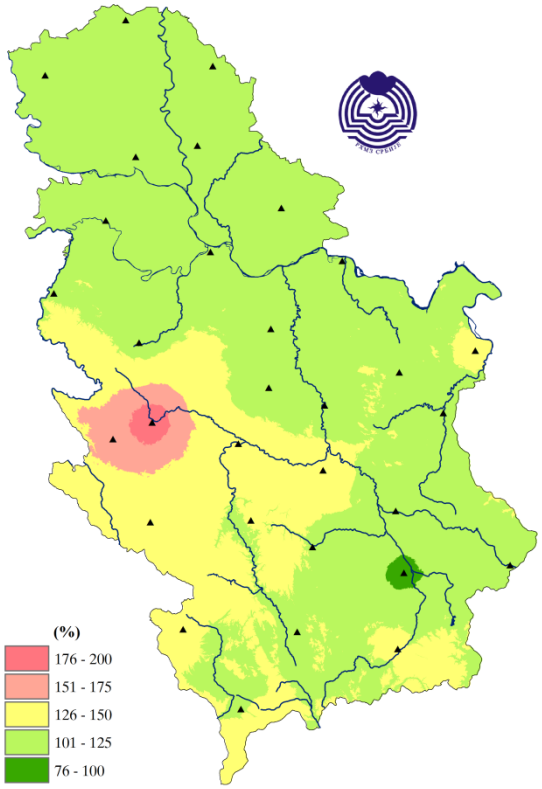

Figure 23. Insolation (percentages of normal) during winter

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

Temperature

During winter, departure of the mean air temperature from the normal for the 1961–1990 base period ranged from -1,8ºC in Leskovac to -0,9ºC in Belgrade, and on the mountains from -1,2ºC at Crni Vrh to -0,2ºC on Zlatibor and Kopaonik (Figure 24).

Based on the percentile method, mean air temperature was in the categories of cold and normal across most of Serbia, and very cold in Dimitrovgrad (Figure 25).

Based on the tercile method, mean air temperature was below the average across most of Serbia, and within the multiannual average in Loznica, Negotin and on the mountains.

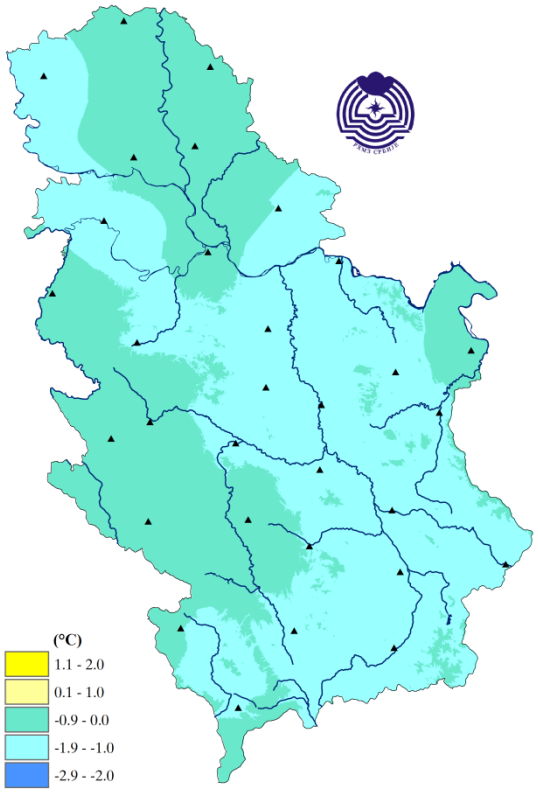

Figure 24. Departure of the mean seasonal air temperature compared to the 1961-1990 base period.

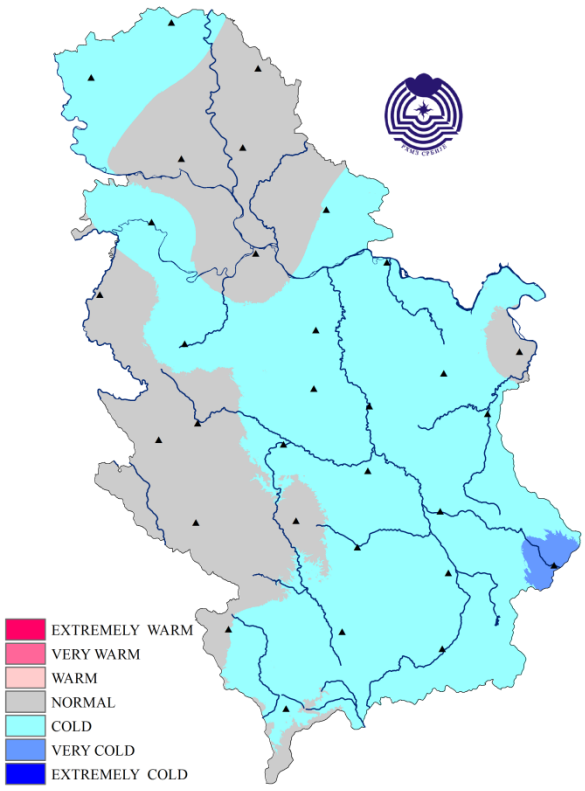

Figure 25. Mean seasonal air temperature using percentile method compared to the 1961-1990 base period

Precipitation

Winter precipitation sums were below average relative to the 1961-1990 base period across most of Serbia. Precipitation sums ranged from 22% in Kikinda to 79% in Loznica compared to the normal (Figure 26).

Based on the percentile method, winter precipitation sums were in the categories of dry and extremely dry across most of Serbia, and dry in Sombor, Sjenica, Leskovac, Vranje and Kopaonik (Figure 27).

Based on the tercile method, precipitation sums were below the average for Serbia.

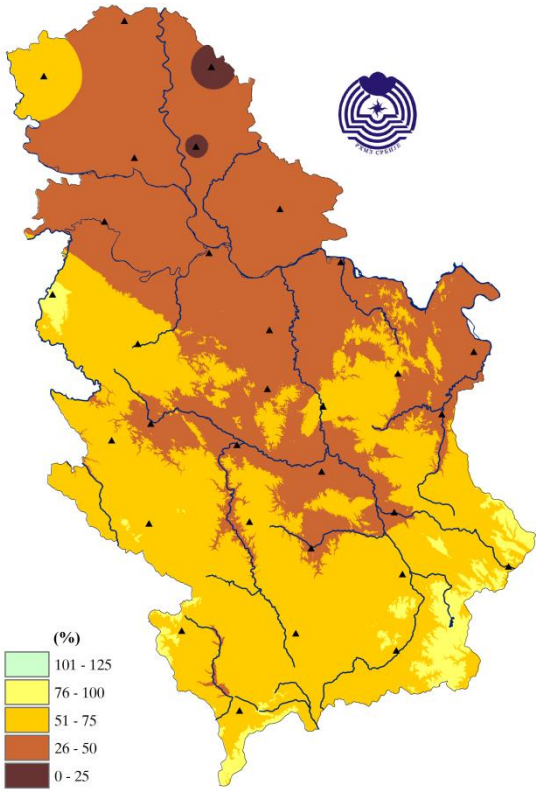

Figure 26. Seasonal precipitation sums expressed in the percentages of normal compared to the 1961-1990 base period

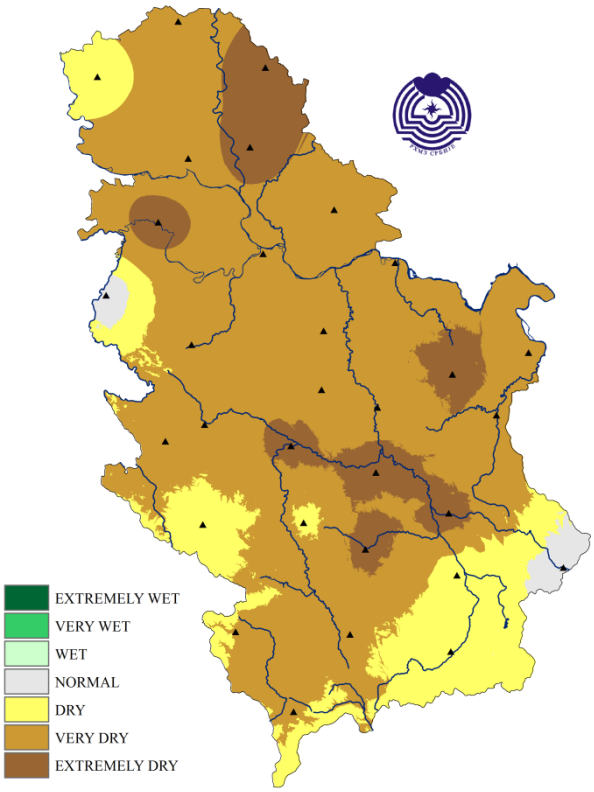

Figure 27. Seasonal precipitation sums using percentile method compared to the 1961-1990 base