VERIFICATION OF THE SEECOF–14 WINTER 2015/2016 CLIMATE OUTLOOK FOR THE TERRITORY OF SERBIA COMPARED TO THE 1981–2010 BASE PERIOD

Temperature

According to the SEECOF-14 outlook for the winter of 2015/2016 in Serbia, above-normal temperature was indicated (above-normal with 55% probability, near-normal with 30% probability and below-normal with 15% probability), compared to the 1981–2010 climatological base period.

Meteorological monitoring showed that the winter 2015/2016 was characterized by warm conditions in entire Serbia with above normal temperature based on tercile method (*Figure* 1).

The outlook for a warm winter was correct. Verification showed that the temperature reached the upper tercile which was indicated in the outlook with the 55% probability.

Precipitation

The SEECOF–14 climate outlook for the winter 2015/2016 indicated wet winter conditions in northern parts of Serbia with 50% probability. Climate outlook didn't show any clear signal for precipitation in the southern part of Serbia (below normal with 33% probability, normal with 34% probability and above normal with 33% probability).

Monitoring of precipitation showed normal to dry winter conditions in most part of Serbia, while northernmost and some parts of eastern Serbia observed wet winter conditions (*Figure* 2). The outlook for a wet winter in north Serbia was correct.

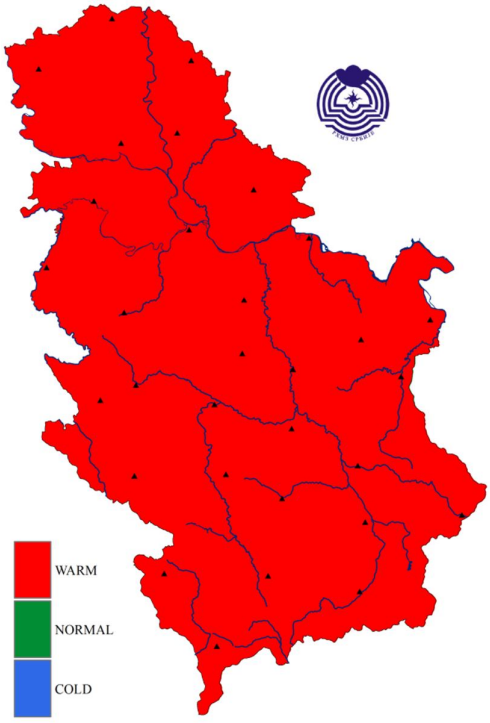


Figure 1. Monitoring of the winter 2015/2016 temperature in Serbia based on tercile method, compared to the 1981-2010 base period

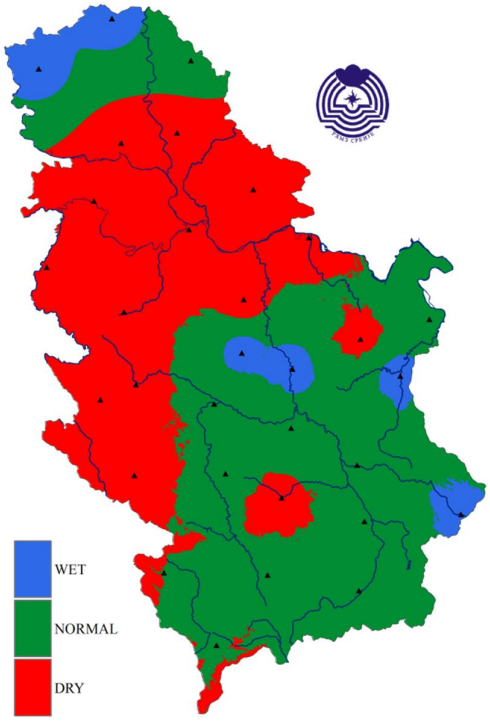


Figure 2. Monitoring of the winter 2015/2016 precipitation in Serbia based on tercile method, compared to the 1981-2010 base period

Winter 2015/16 was extremely warm, the third warmest in Serbia. Record-breaking maximum daily air temperatures for February and winter were observed at twelve main meteorological stations in Serbia. Precipitation sums were within the average in most of the country. Crni Vrh observed record few number of days with snow cover ever since the measurements began.

Analysis of the winter 2015/16 for Serbia compared to the 1961-1990 base period

Temperature

Mean air temperature during winter ranged from 2.0ºC in Pozega to 5.3ºC in Belgrade, and on the mountains from -1.3ºC at Kopaonik to 1.6ºC on Zlatibor (*Figure* 1).

Mean air temperature departure from the normal[1] for the 1961-1990 base period ranged from 2.5ºC in Leskovac, Kraljevo and Dimitrovgrad to 3.6ºC in Negotin and Loznica, and on the mountains from 3.6ºC on Zlatibor and Kopaonik up to 3.7ºC at Crni Vrh (*Figure* 2).

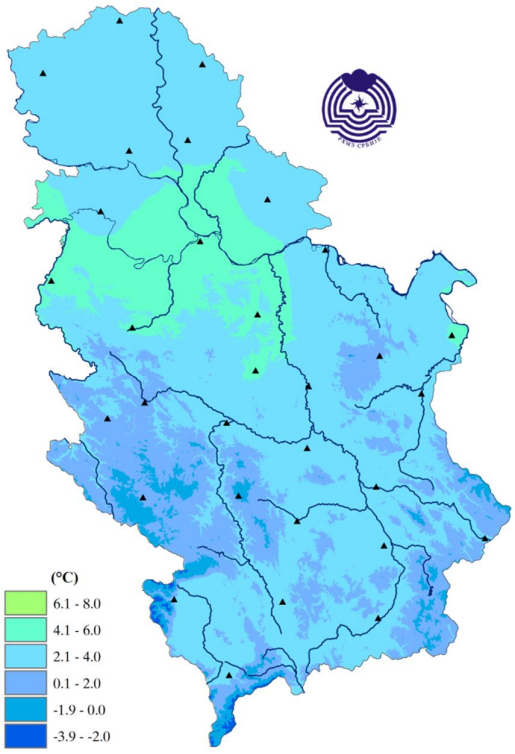


Figure 1. Spatial distribution of the mean seasonal air temperature

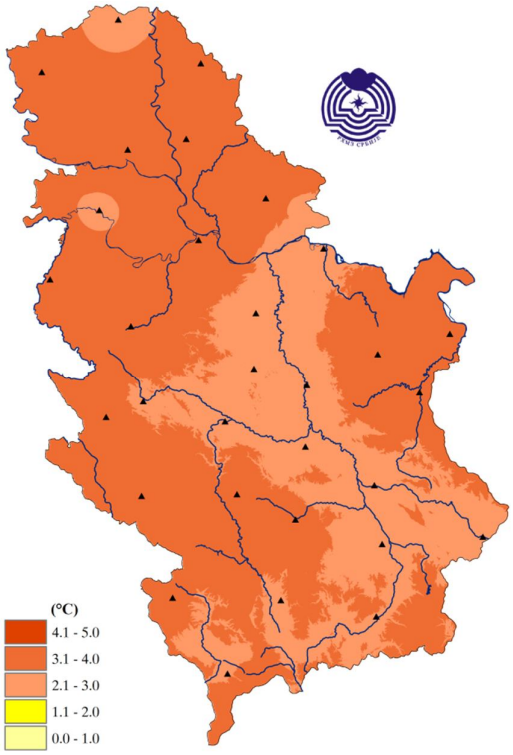


Figure 2. Mean seasonal air temperature anomaly compared to the 1961-1990 base period

[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, 1961 to December 31, 1990

Air temperature during winter was in the extremely warm category across entire Serbia aside from Kraljevo where it was in the very warm category (*Figure* 3).

According to the tercile method, mean air temperature during winter was in the warm category across entire Serbia (*Figure* 4).

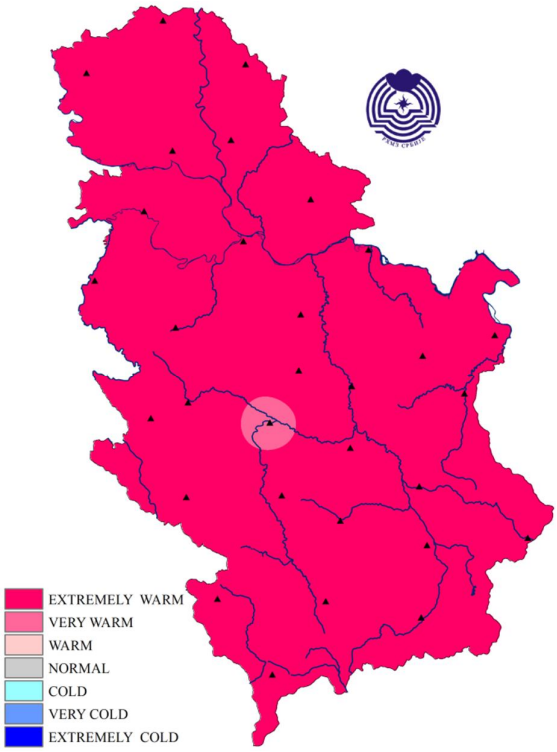


Figure 3. Mean seasonal air temperature based on percentile method

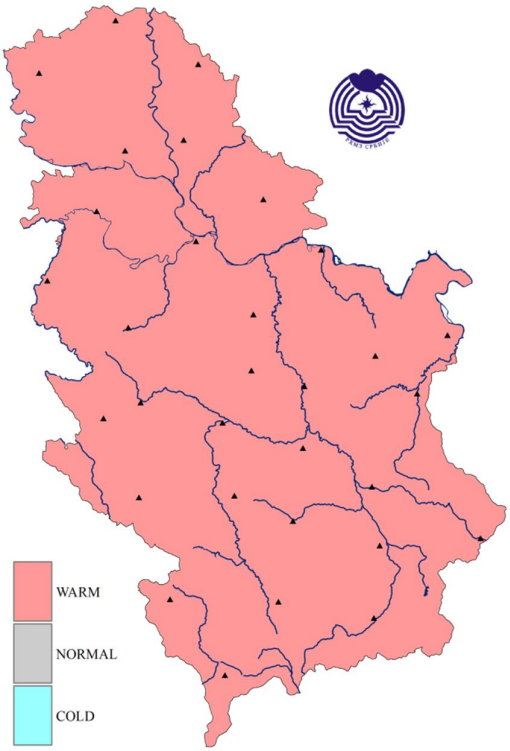


Figure 4. Mean seasonal air temperature based on tercile method

[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

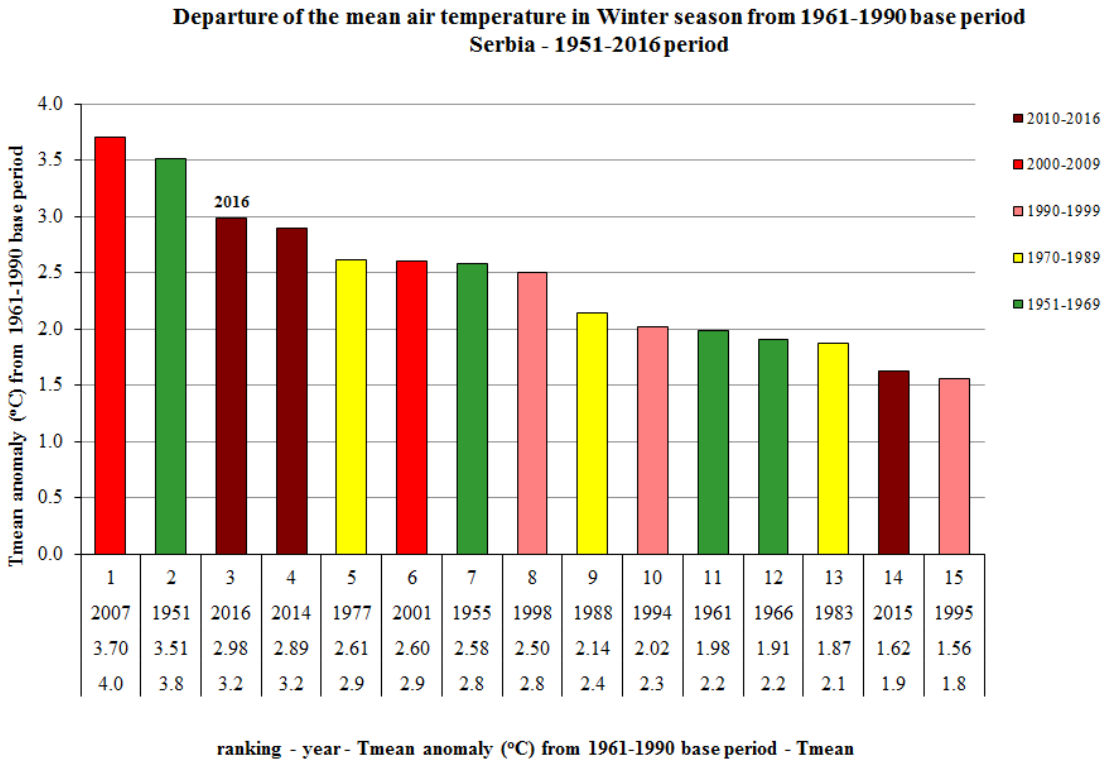


Figure 5. Ranking of the hottest winters in Serbia for the 1951-2016 period

Winter 2015/16 was the third warmest winter on record in Serbia, the second warmest in Loznica, Negotin, Sjenica, Kursumlija and Crni Vrh, and the thirst warmest in Belgrade.

Record-breaking maximum daily air temperatures for February and winter were observed at the twelve main meteorological stations in Serbia. The highest daily air temperature of 25.5°C during winter was measured on February 15 in Krusevac and Cuprija.

Chart 1. Record-breaking air temperatures for February

MMS station	Tmax February 2016	date Tmax	Previous record Tmax	Date of the previous record Tmax
KRAGUJEVAC	**25.2**	15	24.2	25. II 2008
S. PALANKA	**24.9**	15	24.4	25. II 2008
CRNI VRH	**18.8**	22	18.3	23. II 1977
NEGOTIN	**23.5**	23	22.4	26. II 1990
ZLATIBOR	**20.3**	17	19.9	26. II 2008
SJENICA	**20.6**	17	19.4	12. II 1979
KURSUMLIJA	**24.7**	16	23.2	23. II 1977
KRUSEVAC	**25.5**	15	24.2	23. II 1977
CUPRIJA	**25.5**	15	23.8	23. II 1977
NIS	**23.9**	15	23.5	25. II 2008
LESKOVAC	**24.8**	16	23.0	23. II 1977
DIMITROVGRAD	**23.6**	15	23.0	23. II 1977

The number of ice days with the maximum daily air temperature below 0ºC ranged from 4 days in Loznica and Valjevo up to 12 days in Pozega, and on the mountains from 15 days on Zlatibor up to 30 days on Kopaonik. The registered number of ice days was below the average number for winter season, from 8 to 14 days, and on the mountains from 21 to 27 days (*Figure* 6).

The lowest air temperature during winter of -25.6ºC was measured in Sjenica on January 20.

The number of frost days, with the minimum air temperature below 0ºC, ranged from 26 days in Belgrade up to 65 days in Pozega, and on the mountains from 59 days at Crni Vrh up to 77 days at Kopaonik. The number of frost days was from 8 to 28 days below the average for winter (*Figure* 7).

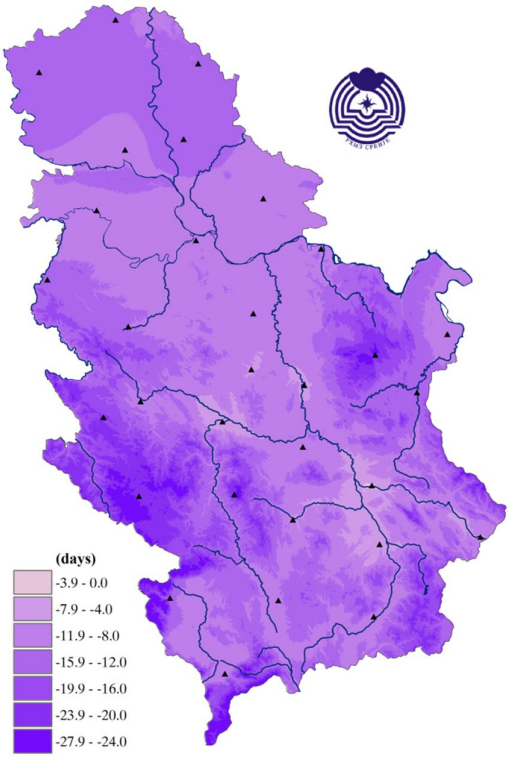


Figure 6. Deviation of the number of ice days compared to the 1961-1990 base period

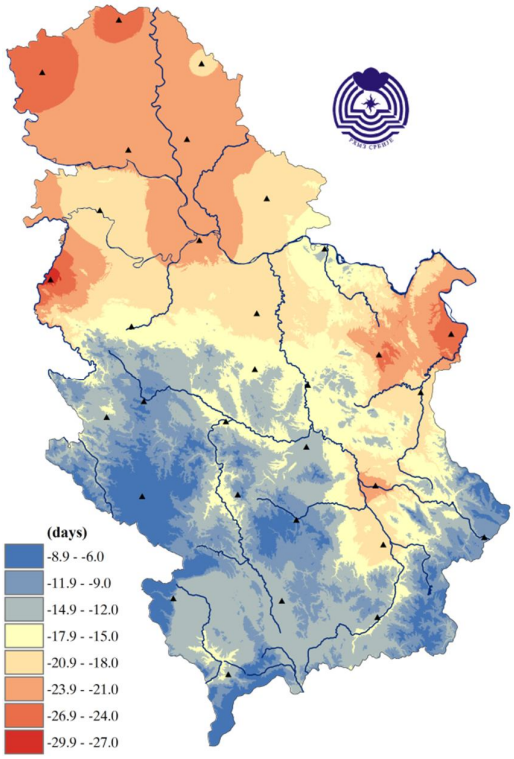


Figure 7. Deviation of the number of frost days compared to the 1961-1990 base period

In Belgrade, maximum and minimum air temperature was above the multiannual average most of the winter, and below the average at the end of December and beginning of January (*Figure* 8).

Three-month course of the mean daily air temperature in Belgrade, Nis and Kopaonik during winter 2015/16 is shown in Figures 9, 10 and 11.

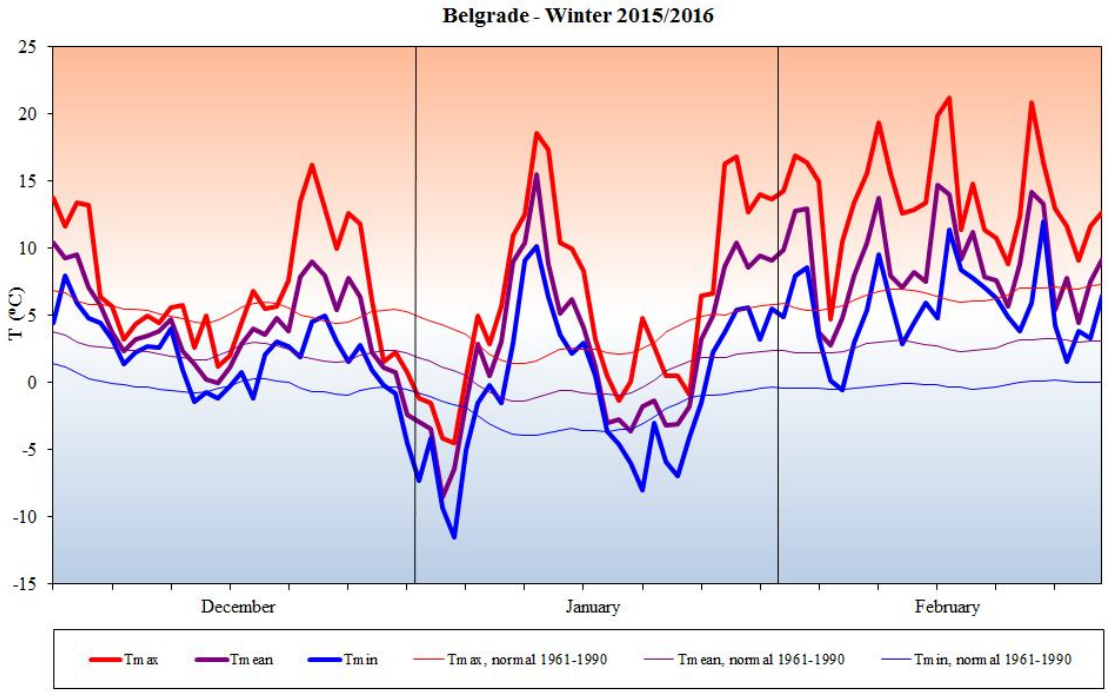


Figure 8. Three-month course of the mean, maximum and minimum air temperature in Belgrade

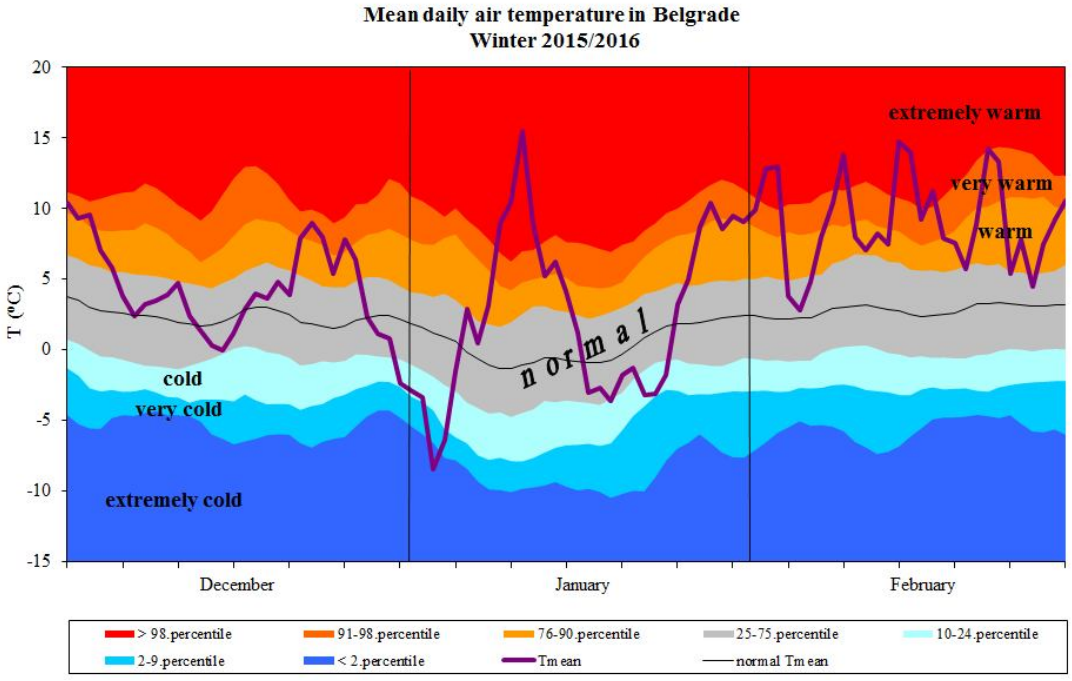


Figure 9. Three-month course of the daily air temperature in Belgrade

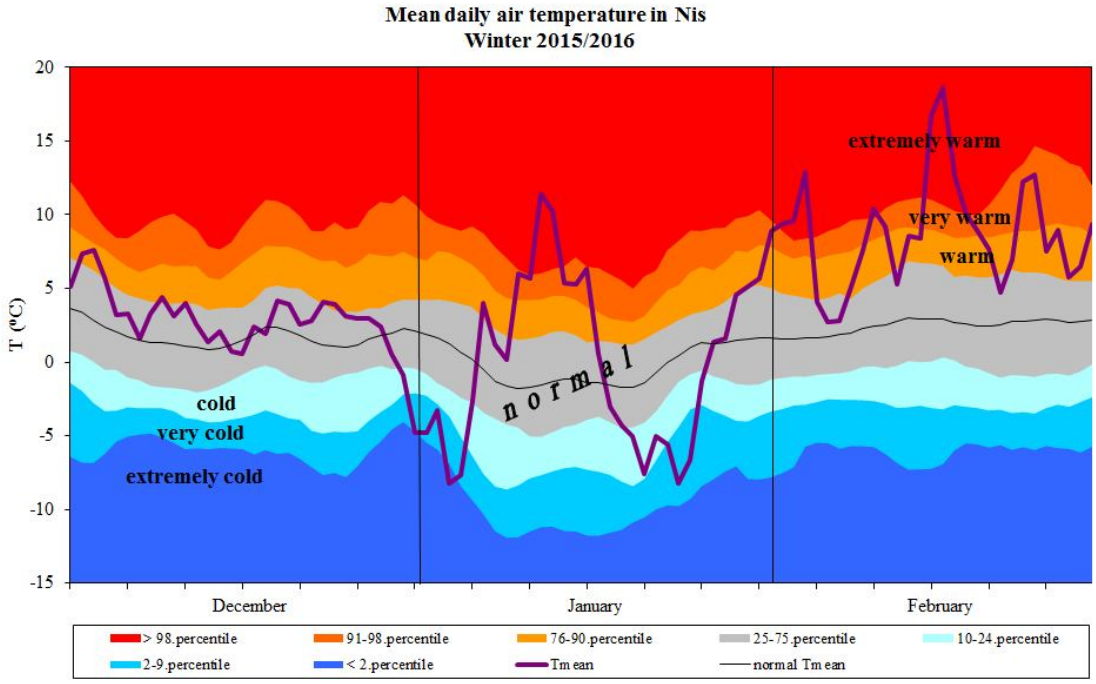


Figure 10. Three-month course of mean daily air temperature in Nis

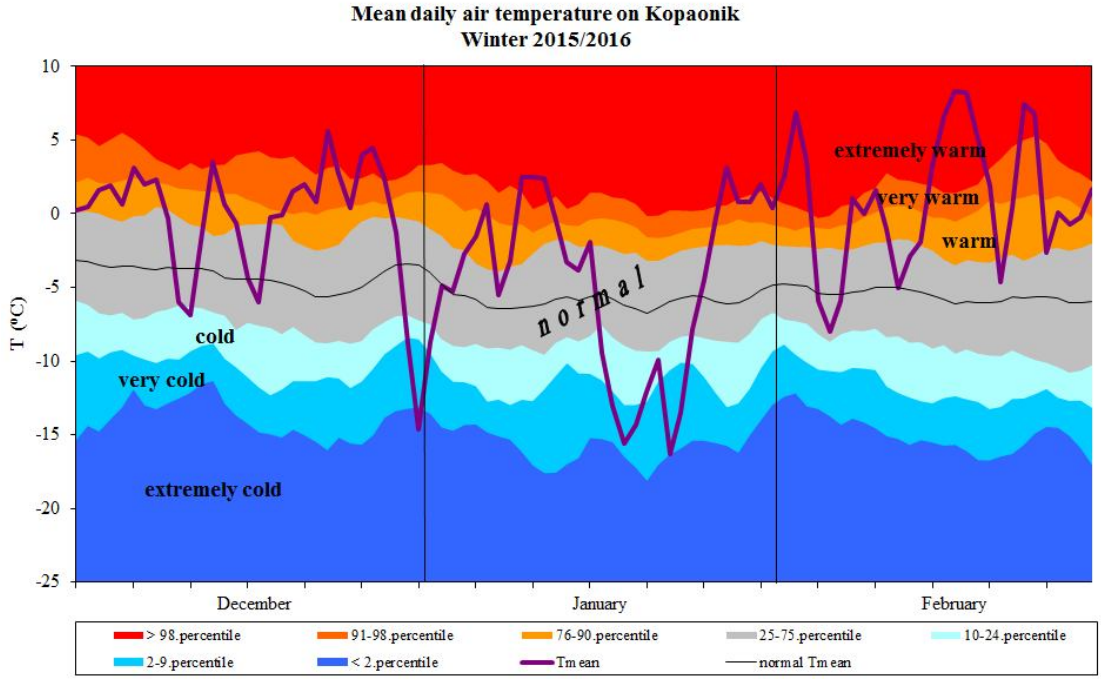
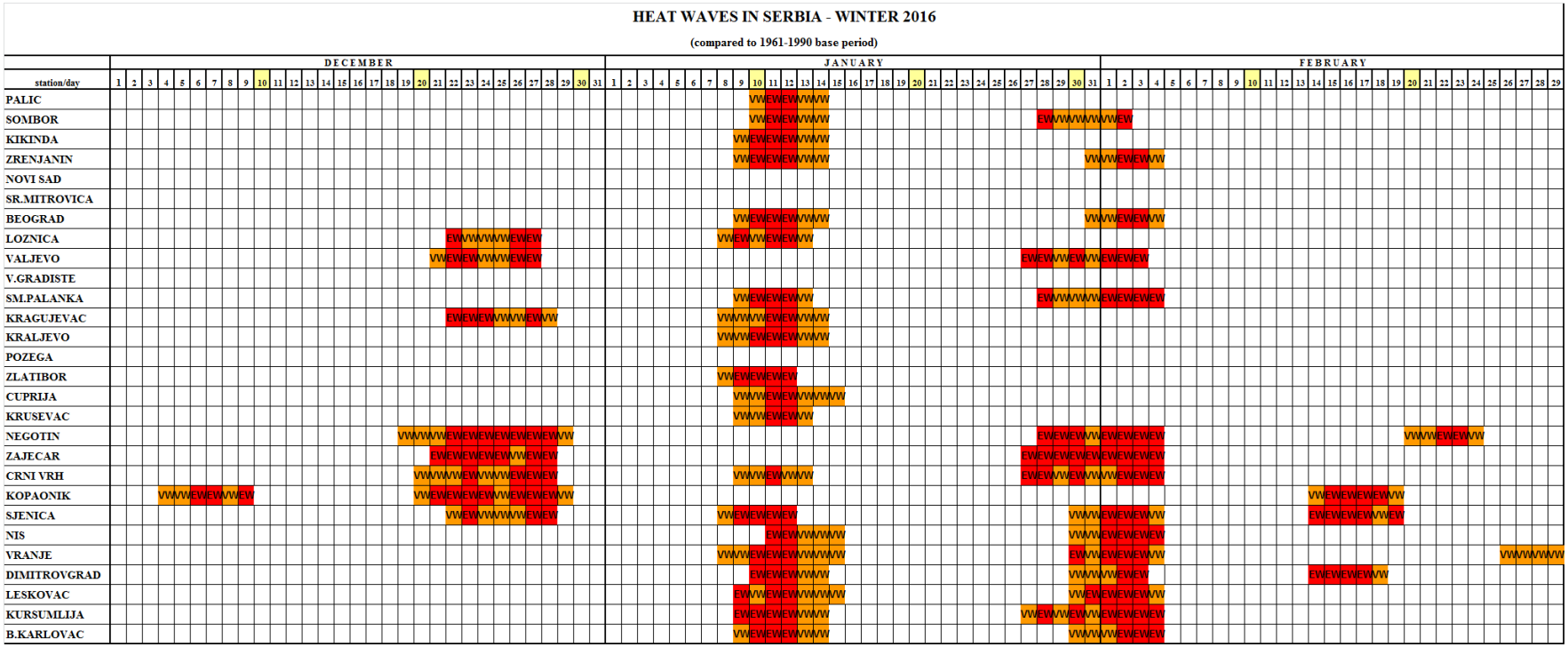


Figure 11. Three-month course of the mean daily air temperature at Kopaonik

Heat and cold waves during winter 2015/16

During winter, one heat wave[3] was registered at eight main meteorological stations, and two heat waves at Kopaonik. Two heat waves were recorded in January. The first heat wave was observed in most of the country, lasting from January 8 to 14. The second heat wave had its onset at the end of January continuing throughout February in most of the country. The heat wave that began at the end of January lasted until February 4 at most places. Kopaonik, Sjenica and Dimitrovgrad, observed the second heat wave in the middle of February, and one more subsequent heat wave was registered in Negotin, lasting from February 20 to 24 and in Vranje starting from February 26 until the end of the month.



Legend: VW – very warm; EW – extremely warm

Between December 29 and January 5, cold wave[4] was registered in Veliko Gradiste, Negotin, Zajecar and Crni Vrh. The second was observed between January 19 and 25 in Veliko Gradiste, Zajecar and Dimitrovgrad.

[3] Heat wave intensity indicates sum of departures of maximum air temperature (days encompassed by heat wave) from the mean maximum air temperature for the reference climatological period

[4] Cold wave, 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 consecutive days or longer

Precipitation

During winter, precipitation totals were within the average compared to the normal for the 1961-1990 base period in most of Serbia, ranging from 79.0 mm in Banatski Karlovac up to 200.9 mm at Kopaonik. Precipitation sums compared to the normal were in a range from 58% in Banatski Karlovac to 137% in Dimitrovgrad (*Figure* 12).

According to the percetile method, precipitation sums during witner were in the categories of normal and dry in most of Serbia and rainy category in Dimitrovgrad (*Figure* 13).

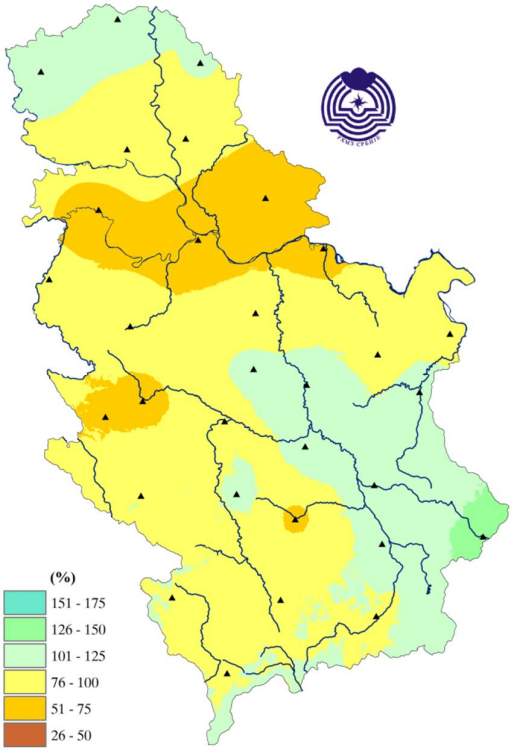


Figure 12. Spatial distribution of the precipitation totals expressed in the percentages of normal

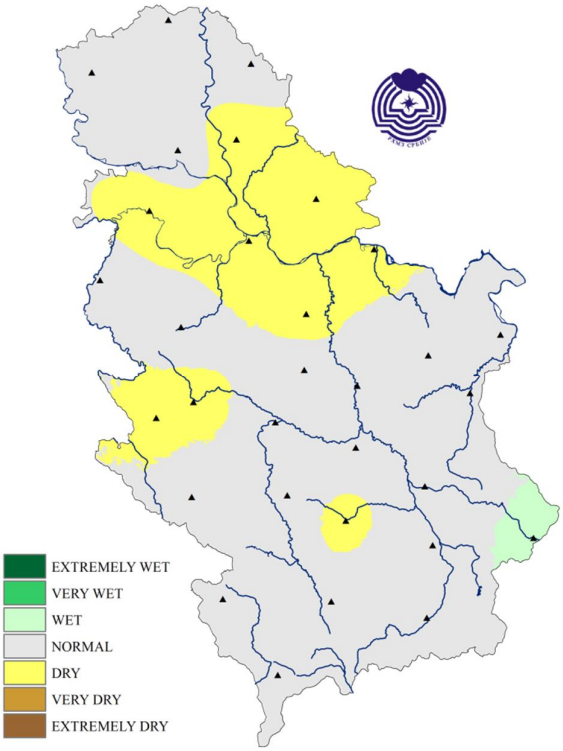


Figure 13. Precipitation sums based on percentile method based

Based on tercile method, precipitation sums were within the average across most of Serbia, and below the average in parts of western, central and eastern Serbia (*Figure* 14).

The maximum daily precipitation sum of 34.7 mm was observed in Vranje on January 7.

The registered number of days with precipitation of 1 mm and above ranged from 14 days in Zajecar up to 29 days at Kopaonik. The registered number of days with precipitation of 1mm and above was above the average in northern and parts of central Serbia whereas elsewhere it was below the average (*Figure* 15).

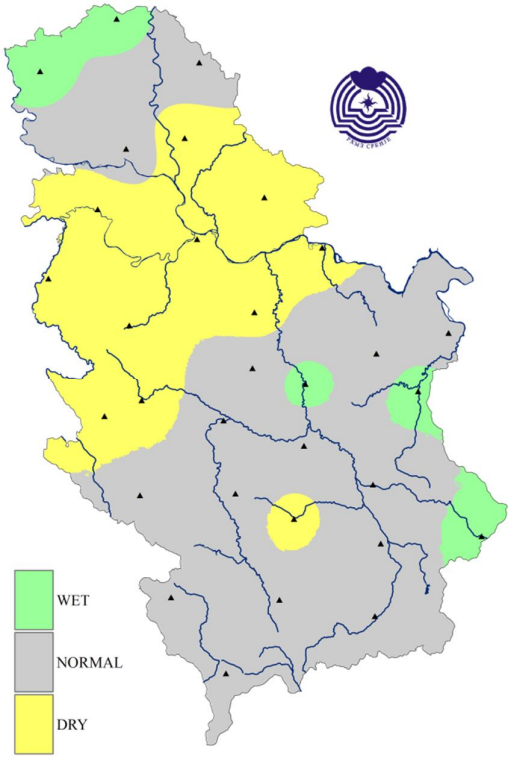


Figure 14. Precipitation sums based on tercile method

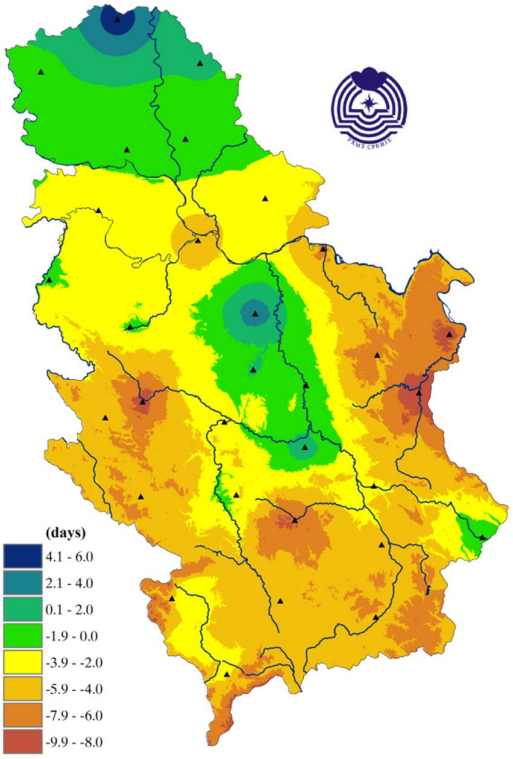


Figure 15. Deviation of the number of days with precipitation of 1.0 mm and above

The number of days with snow cover, in the low-lying areas of Serbia was in a range from 3 in Kikinda to 24 days in Negotin and Dimitrovgrad. The number of days with snow cover on the mountains varied from 30 days on Crni Vrh up to 89 days at Kopaonik. The registered number of days with snow cover was between 15 to 35 days below the average number for winter (*Figure* 16), and 53 days at Crni Vrh. The registered number of days at Crni Vrh was simultaneously the fewest number of days since the measurements began at that station. The maximum snow depth of 78 cm was measured on January 18.

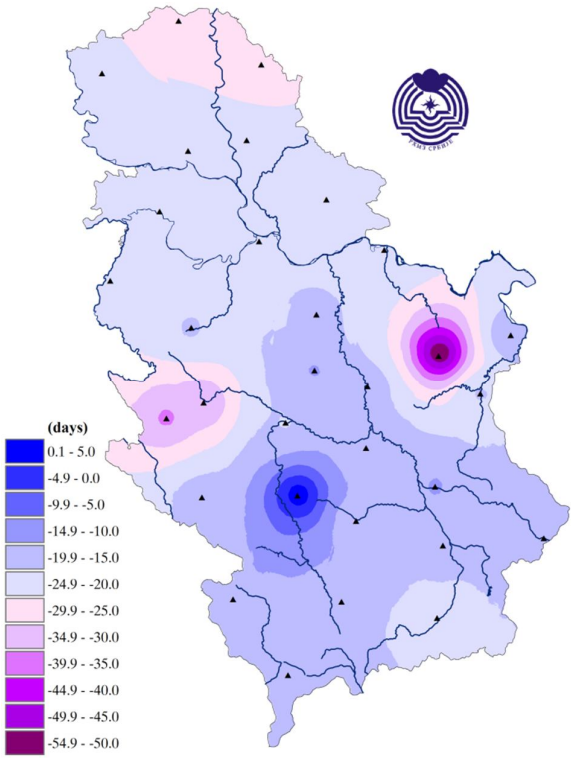


Figure 16. Deviation of the number of days with snow cover

Figures 17 and 18 show cumulative precipitation sums for Belgrade and Negotin during winter and per month compared to the average cumulative sums.

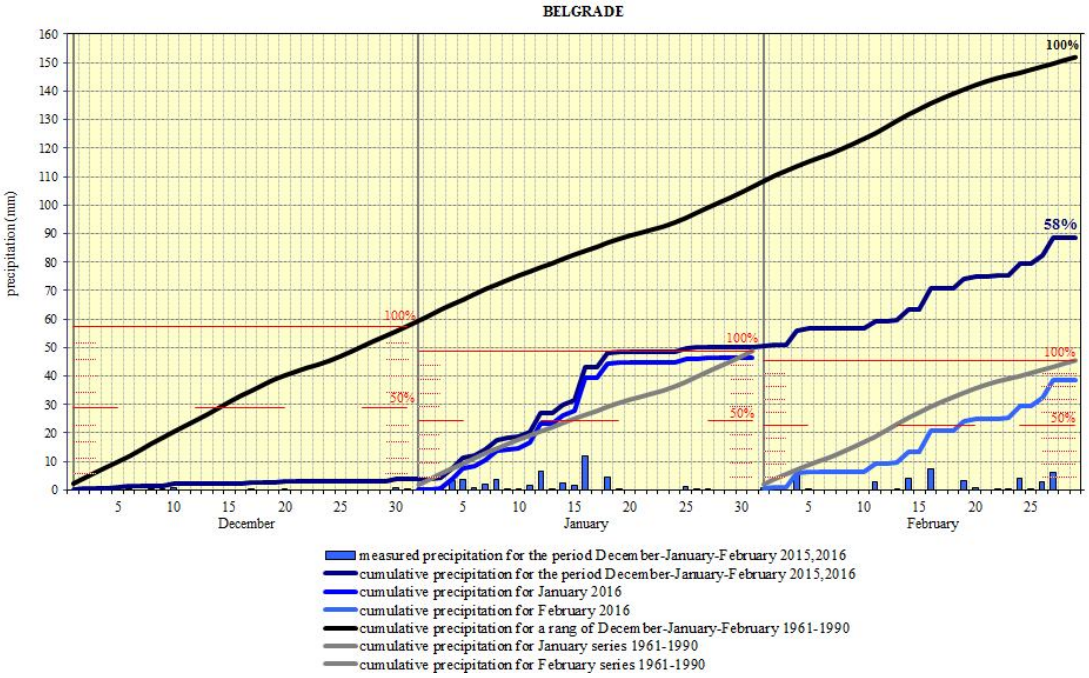


Figure 17. Cumulative precipitation sums for Belgrade

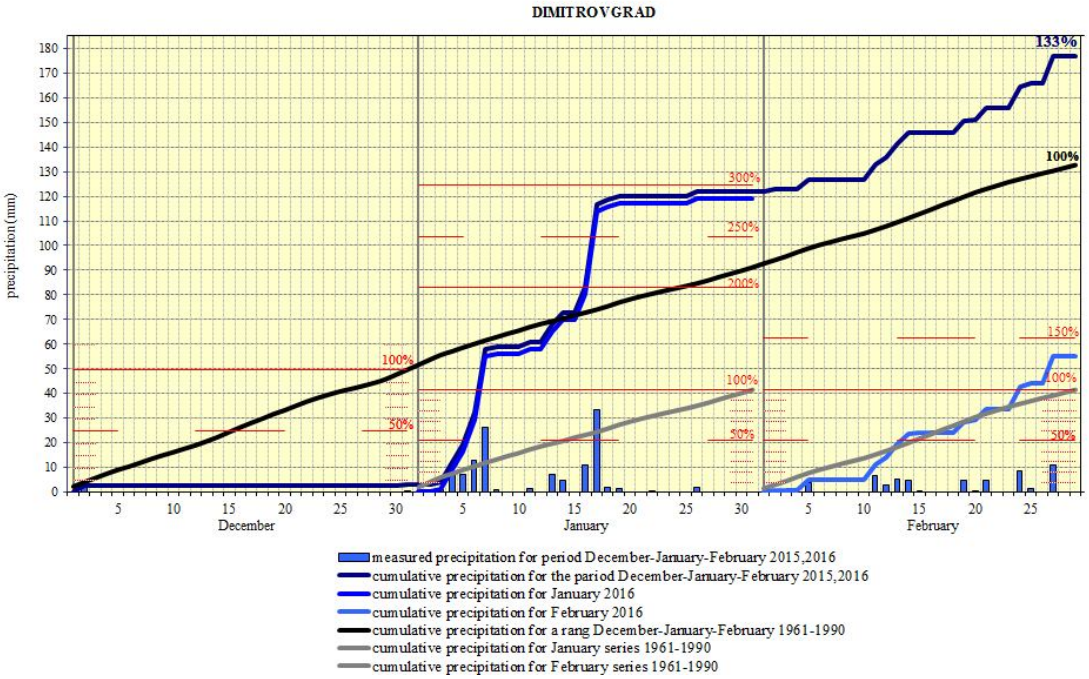


Figure 18. Cumulative precipitation sums for Dimitrovgrad

Sunshine duration (insolation)

During winter, insolation was above the average in southern and eastern Serbia, ranging from 166.9 on Palic to 319.1 hours on Kopaonik (*Figure* 19).

Compared to the normal for the 1961-1990 base period, sunshine duration was in a range from 75% on Palic to 168% in Kursumlija (*Figure* 20).

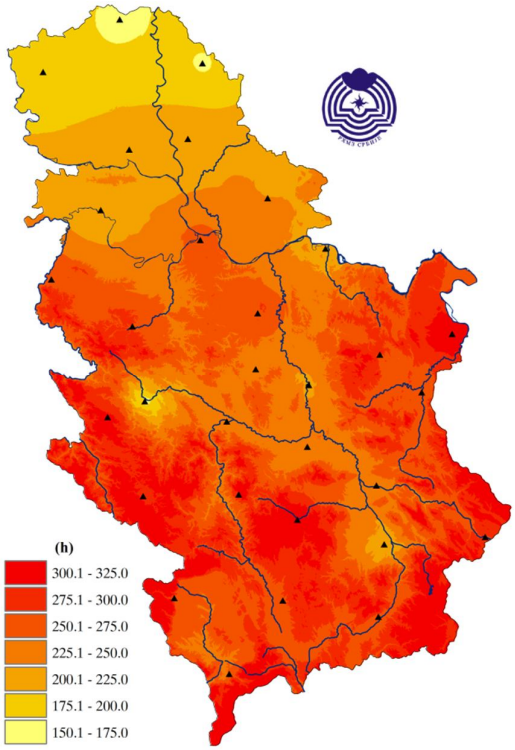


Figure 19. Insolation expressed in hours

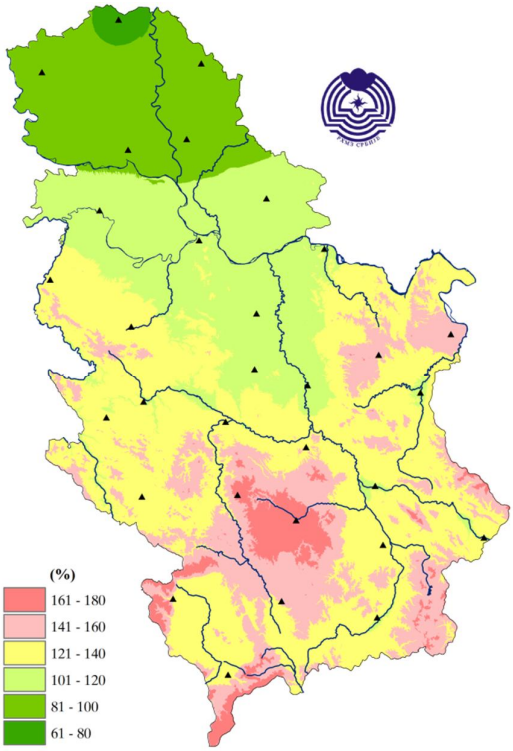


Figure 20**.** Insolation expressed in the percentages of normal

Analysis of the winter 2015/16 for Serbia compared to the 1981-2010 base period

Temperature

During winter, mean air temperature departure from the normal for the 1981-2010 base period ranged from 2.2ºC in Leskovac to 3.8ºC in Belgrade, and on the mountains from 3.1ºC on Zlatibor and Kopaonik to 3.5ºC at Crni Vrh (*Figure* 21).

According to the percentile method, the mean air temperature was in the very warm category across most of Serbia, and extremely warm in parts of western, southern and eastern Serbia (*Figure* 22).

According to the tercile method, mean air temperature was above the average values in entire Serbia.

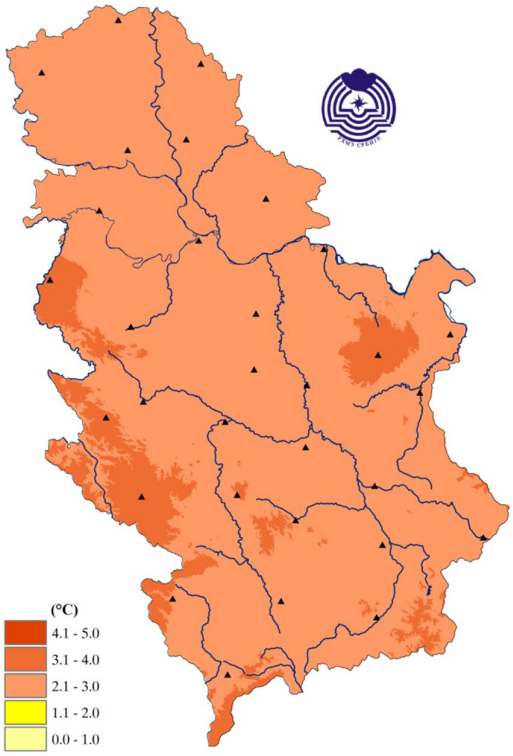


Figure 21. Mean seasonal air temperature anomaly compared to the 1981-2010 base period

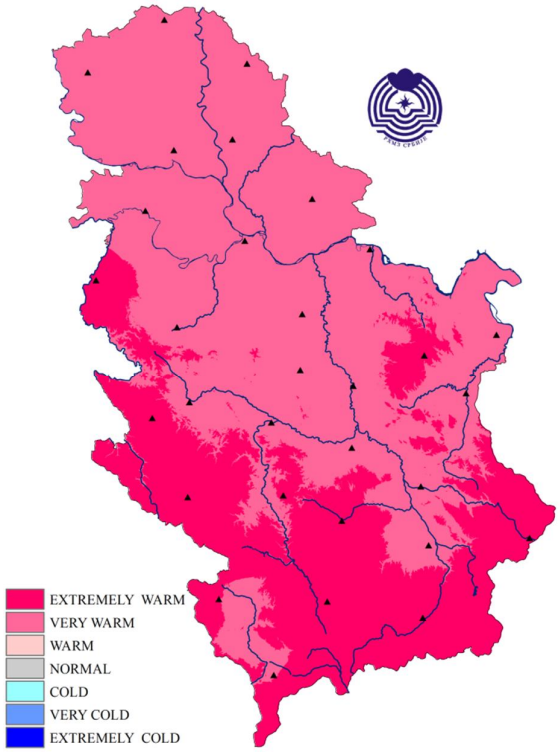


Figure 22. Mean seasonal air temperature in Serbia based on percentile method

Precipitation

In most of Serbia, precipitation totals during winter were near average compared to the normal for the 1981-2010 base period. Precipitation sums ranged from 61% in Belgrade to 142% in Dimitrovgrad compared to the normal (*Figure* 23).

According to the percentile method, precipitation sums during winter were in the categories of normal and dry across most of Serbia, and rainy in Sombor, Dimitrovgrad and Palic (*Figure* 24).

According to the tercile method, precipitation totals were below the average in most of Serbia.

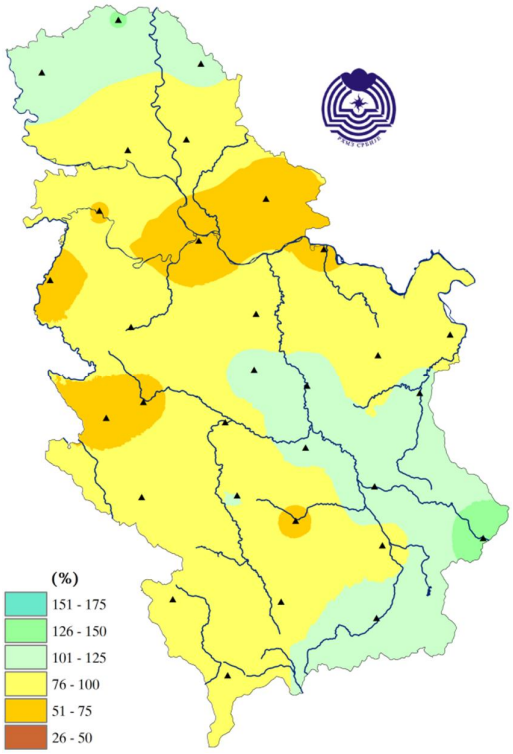


Figure 23. Precipitation sums expressed in the percentages of normal

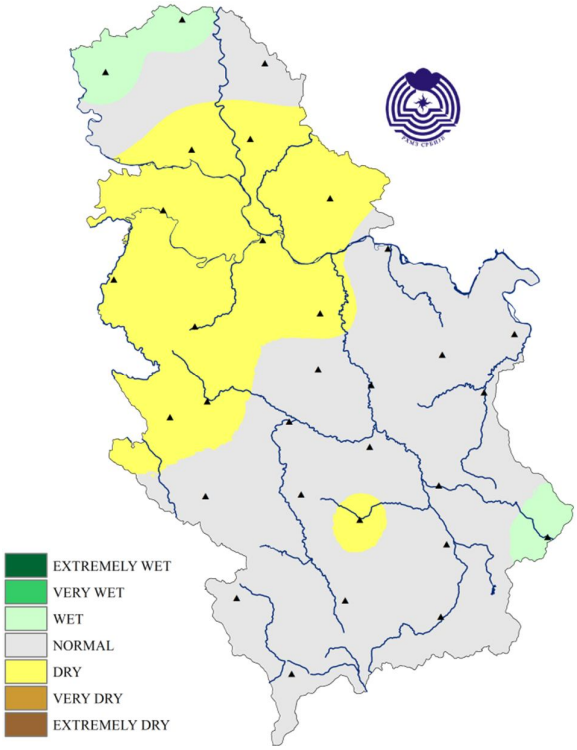


Figure 24. Precipitation sums based on percentile method

Winter 2015/2016			Air Temperature (°C)			
Station	Rank*	Rank**	33	50	66	Observed value
Beograd (1888-2015)	3	3	1.5	2.4	3.0	5.3
Palić (1946-2015)	5	4	-0.1	0.5	1.5	3.0
Sombor (1942-2015)	4	3	0.0	0.9	1.8	3.5
Novi Sad (1949-2015)	4	2	0.4	1.1	1.8	4.0
Zrenjanin (1944-2015)	5	5	0.3	1.0	1.8	3.9
Kikinda (1949-2015)	5	5	0.1	0.9	1.7	3.5
Banatski Karlovac (1986-2015)	5	5	0.7	1.4	2.0	3.8
Loznica (1923-2015)	2	2	0.7	1.8	2.5	4.9
Sremska Mitrovica (1926-2014)	4	2	0.4	0.9	1.6	3.7
Valjevo (1927-2015)	4	2	0.7	1.3	2.2	4.4
Kragujevac (1926-2015)	4	3	0.9	1.5	2.3	4.4
Smederevska Palanka (1940-2015)	4	3	0.7	1.5	2.1	4.2
Veliko Gradište (1927-2015)	7	3	0.4	1.0	1.6	3.5
Crni Vrh (1967-2015)	2	2	-3.6	-3.2	-2.1	0.6
Negotin (1928-2015)	2	2	0.7	1.1	1.8	4.1
Zlatibor (1951-2015)	3	2	-2.2	-1.8	-0.8	1.6
Sjenica (1947-2015)	2	1	-3.4	-2.5	-2.0	0.3
Pozega (1953-2015)	3	2	-1.3	-0.7	0.3	2.0
Kraljevo (1927-2015)	7	5	0.5	1.1	2.1	3.7
Kopaonik (1950-2015)	3	2	-5.0	-4.6	-3.8	-1.3
Kursumlija (1953-2015)	2	2	0.3	1.0	1.5	3.8
Krusevac (1931-2015)	8	5	0.7	1.1	1.9	3.5

Cuprija (1949-2015)	7	5	0.4	1.2	1.7	3.5
Nis (1926-2015)	7	5	1.1	1.6	2.3	4.0
Leskovac (1949-2015)	6	5	0.3	0.9	1.7	3.3
Zajecar (1930-2015)	3	2	0.0	0.4	1.1	3.4
Dimitrovgrad (1946-2015)	5	3	-0.5	0.0	1.1	2.7
Vranje (1927-2015)	5	3	0.3	1.0	1.7	3.7

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

Winter 2015/2016			Precipitation sums (mm)			
Station	Rank*	Rank**	33	50	66	Observed Value
Beograd (1888-2015)	101	29	129.8	152.3	158.3	88.6
Palić (1945-2015)	20	10	90.1	104.4	121.5	136.7
Sombor (1942-2015)	32	11	104.2	114.8	123.0	134.3
Novi Sad (1948-2015)	52	28	109.9	119.1	133.5	104.1
Zrenjanin (1946-2015)	74	29	106.5	115.7	127.0	87.2
Kikinda (1948-2015)	50	17	98.0	105.5	121.2	113.9
Banatski Karlovac (1946-2015)	59	28	108.3	122.7	132.5	79.0
Loznica (1925-2015)	19	29	166.4	171.6	201.4	126.4
Sremska Mitrovica (1925-2015)	78	29	103.0	115.9	130.1	83.4
Valjevo (1926-2015)	58	27	149.5	157.6	173.3	135.3
Kragujevac (1925-2015)	35	13	113.0	120.0	134.0	137.0
Smederevska Palanka (1939-2015)	66	29	121.8	132.7	157.6	102.7

Veliko Gradište (1926-2015)	68	27	120.8	147.9	161.3	97.9
Crni Vrh (1967-2015)	35	26	127.6	143.8	170.7	123.4
Negotin (1927-2015)	41	20	105.9	137.3	186.9	136.7
Zlatibor (1950-2015)	54	31	204.3	225.1	237.8	144.9
Sjenica (1946-2015)	45	26	140.9	151.4	177.6	139.6
Pozega (1952-2015)	75	29	124.3	147.5	157.6	93.6
Kraljevo (1926-2015)	40	17	126.9	137.3	156.8	147.3
Kopaonik (1950-2015)	22	19	158.1	204.0	232.1	200.9
Kursumlija (1952-2015)	73	28	123.5	150.9	174.5	96.5
Krusevac (1927-2015)	36	18	115.1	133.2	155.6	141.9
Cuprija (1948-2015)	22	13	127.5	148.1	163.1	167.6
Nis (1925-2015)	31	14	117.7	137.1	150.6	148.1
Leskovac (1948-2015)	41	23	127.3	150.4	161.8	135.4
Zajecar (1929-2015)	30	15	103.7	136.3	146.6	146.6
Dimitrovgrad (1945-2015)	15	8	111.6	120.4	143.9	177.0
Vranje (1926-2015)	46	17	111.7	126.9	137.1	130.5

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

Country	Seasonal temperature DJF		Seasonal precipitation DJF		High Impact Events
	Observed	SEECOF-14 climate outlook for temperature	Observed	SEECOF-14 climate outlook for precipitation	
Serbia (1)	Above normal	**Above normal** (15, 30, 55) whole Serbia	Below normal to normal in most part of Serbia, above normal in northernmost and some eastern parts	**Above normal** (20,30,50) northern Serbia **No predictive signal** (33, 34, 33) southern Serbia	**Winter 2015/2016** was extremely warm, the **third warmest** in Serbia. Record-breaking maximum daily air temperatures for February and winter were observed at twelve main meteorological stations in Serbia. Crni Vrh observed record few number of days with snow cover ever since the measurements began.