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ANNUAL BULLETIN FOR SERBIA THE YEAR OF 2019

Belgrade, 14 January 2020

CONTENT

2019 – THE YEAR OF CLIMATE RECORDS IN SERBIA

- ❖ *The warmest year for Serbia since 1951, the warmest year for Belgrade since 1888*
- ❖ *Mean air temperature in Serbia was 12,3℃ , by 0,3℃ above the previous record warm 2018*
- ❖ *Mean air temperarure for Belgrade was 14,7℃, by 0,2℃ above the previous record warm 2018*
- ❖ *The 3rd warmest June for Serbia, based on the minimum air temperature warmest on record*
- ❖ *The warmest October for Serbia based on the maximum air temeprature*
- ❖ *The warmest November for Serbia*
- ❖ *The warmest autumn for Serbia*

Air temperature

At the territory of Serbia, the year of 2019 with its mean air temperature of 12.3℃ ranks as the warmest on record in the period from 1951 up to date. Belgrade observed the mean air temperature of 14,7℃ making the year of 2019 warmest since the record-keeping began (in 1888). Mean air temperature ranged from 10,9℃ in Pozega to 14,7℃ in Belgrade, and on the mountains from 5,2℃ at Kopaonik to 9,4℃ at Zlatibor. Departure of the mean annual air temperature relative to the 1981-2010 base period ranged from 1,2℃ in Zajecar adn Pozega to 2,2℃ in Belgrade. Based on the percentile distribution[1], the year of 2019 fell under the extremely warm category across the entire country apart from Zajecar where it was in the very warm category.

Thirteen out of fifteen warmest years in Serbia was recorded after 2000 (in the 1951-2019 period), and in Belgrade fourteen warmest years was registered (in the 1888-2019 period).
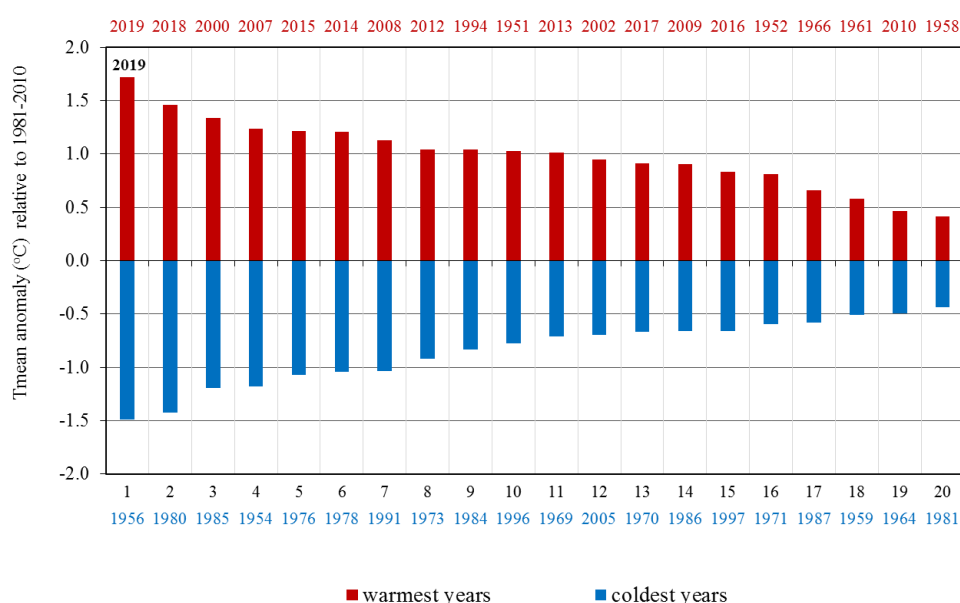

Figure 1. Rank of the warmest and coldest years for Serbia for the 1951-2019 base period

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[1] **n**- nth 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
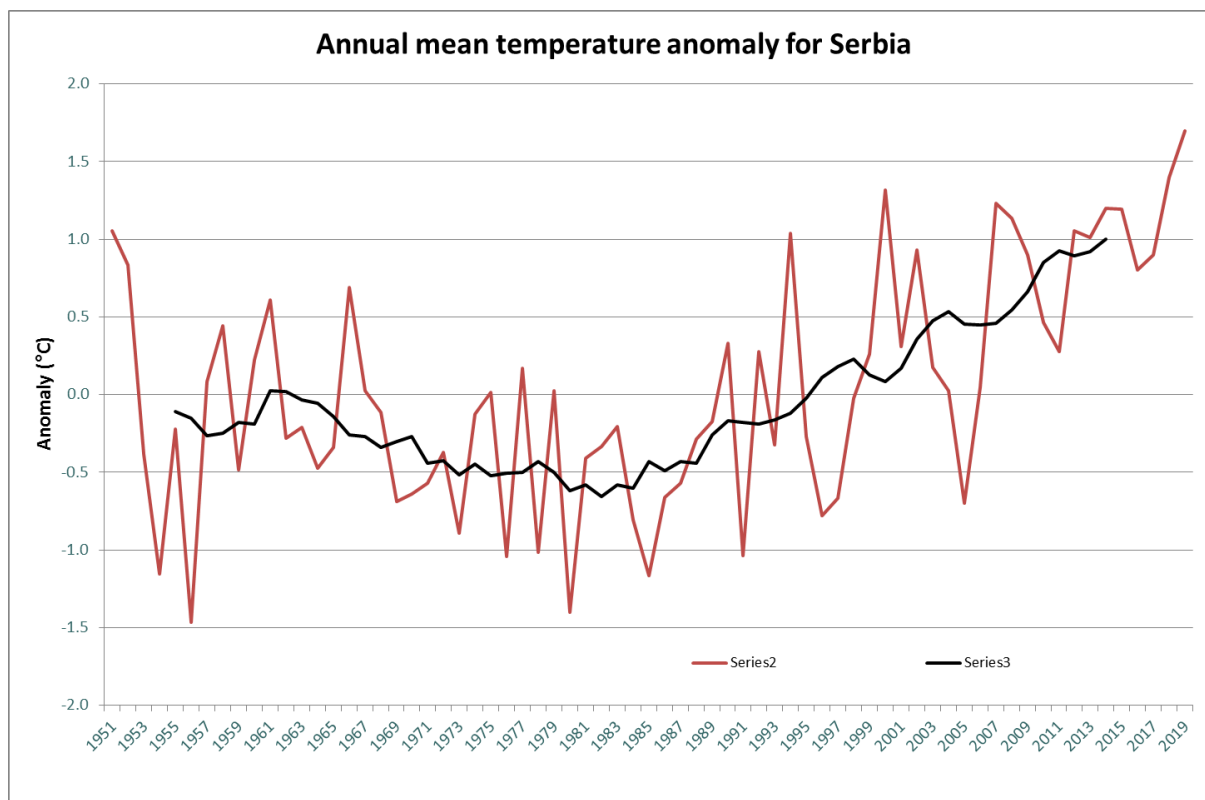
Figure 2. Trend of the mean annual air temperature anomaly for Serbia, 1951-2019 period

In 2019, the highest daily air temperature of 38,1ºC was measured in Leskovac on August 12. The highest number of tropical days[2], total of 71 days, was recorded in Negotin and Leskovac. In most of Serbia, number of tropical days was 3 to 29 days above the average number for the 1981-2010 base period. Belgrade observed 59 tropical days which is 22 days above the average.

Belgrade experienced 48 tropical nights[3] у Београду, which 31 days above the average. Negotin and Zrenjanin recorded 14 tropical nights, Palic and Loznica 11, elsewhere number of tropical night was less than 8.

The lowest daily air temperature of -22,1ºC was measured in Sjenica on January 8. In the lowland, there were up to 6 days with severe frost[4], and on the mountains their number ranged from 7 at Zlatibor and Crni Vrh to 24 days at Kopaonik. Most of Serbia observed 1 to 15 days with severe frost below the average.

In 2019, number of ice days[5] in Serbia ranged from 1 in Loznica to 12 in Vranje, and in the upland from 28 in Sjenica to 59 days at Kopaonik.

Based on the analysis of the mean minimum and mean maximum air temperature for Serbia, the year of 2019 ranks as the warmest according to the maximum air temperature, whilst 2019 ranks as the 3rd warmest according to the minimum air temperature (only behind 2014 and 2018).

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[2] Tropical day is defined as the day with the maximum daily air temperature of 30°C and more
[3] Tropical night is defined as the night with the minimum daily air temperature of 20°C and more
[4] Day with severe frost is defined as the day with the minimum daily air temperature of–10°C and less
[5] Ice day is defined as the day with maximum air temperature below 0°C
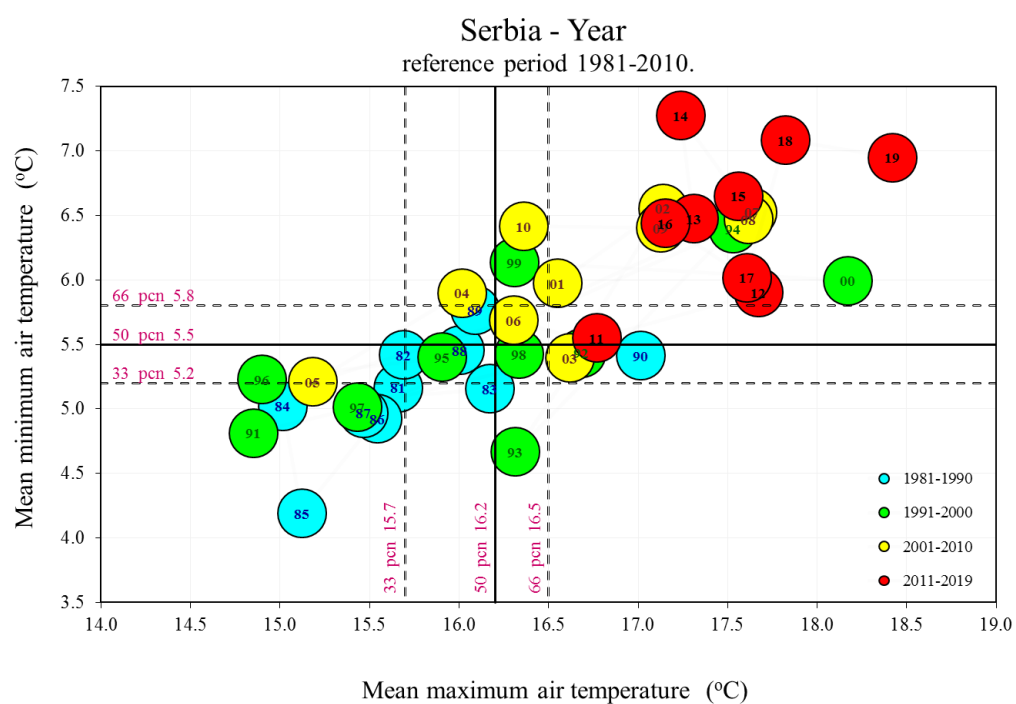
Figure 3. Mean minimum and mean maximum air temperature and their accompanying terciles for Serbia for the 1981-2019 period
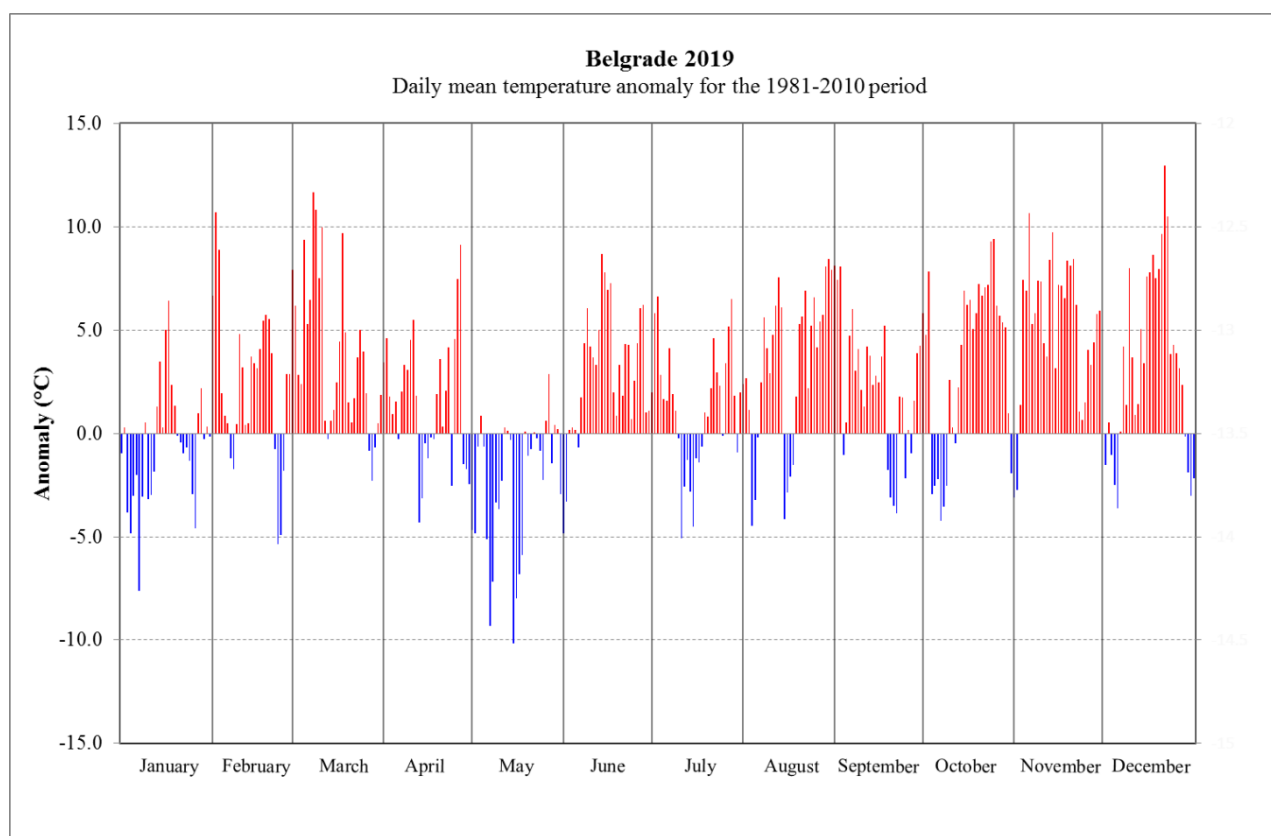

Figure 4. Daily departure of the mean air temperature from the normal 1981-2010 for Belgrade

Precipitation

In most of Serbia, the year of 2019 was averagely rainy. Very rainy was in Pozega, very dry at Zlatibor and dry in southeastern Serbia. Precipitation sums ranged from 506,5 mm in Vranje to
855,7 mm in Pozega, and on the mountains from 739,7 mm at Crni Vrh to 1152,3 mm at Kopaonik. Percentage of the precipitation sums relative to the normal 1981-2010 ranged from 80 at Zlatibor to 118 in Pozega.

Number of rainy days ranged from 99 in Negotin to 148 in Pozega, and in the upland from 161 at Crni Vrh and Sjenica to 165 days at Kopaonik.

The highest daily precipitation sum of 84,2 mm was recorded in Kraljevo on April 3.

Number of days with snow cover ranged from 17 on Palic to 40 in Pozega, and in the upland from 85 in Sjenica to 139 at Kopaonik. The highest snow cover depth of 117cm was measured at Kopaonik on February 14 and 15. As for the lowland, the highest snow cover depth of 39cm was observed in Kraljevo on January 12.
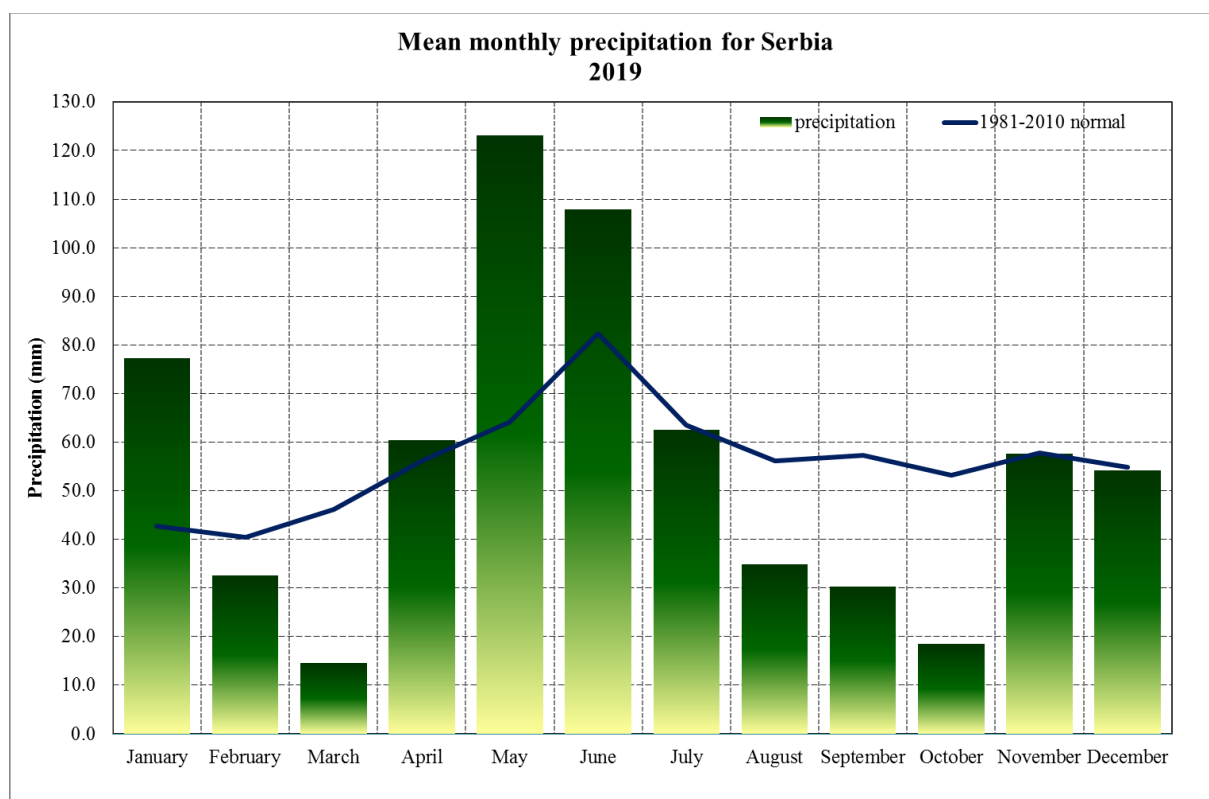

Figure 5. Mean monthly precipitation sums for Serbia

Heat waves and cold waves

In the 2019, most of Serbia experienced 3 heat waves[6], whilst some places observed even up to 5 heat waves.

In the period from February 16 to 20, heat wave was registered in Negotin, Kikinda and Palic. In the period from March 4 to 11, heat wave was recorded in Sjenica, Vranje, Leskovac and Kursumlija.

In the period from June 12 to 16, heat wave was recorded at Zlatibor whereas Pozega, Vranje, Dimitrovgrad, Leskovac, Sjenica and Kopaonik observed heat wave in the period from August 7 to 13. Heat wave with the duration of 11 days was observed in most of Serbia in the period from August 23 to September 2.

In the period from September 28 to October 2, heat wave was recorded in Kraljevo and Pozega. Heat wave, with the total duration of 18 days encompassed the entire country in the period from October 12 to 29. Vranje and Negotin observed heat waves in the period from November 10-19 and November 11-15 respectively.

In 2019, cold waves were not registered[7].

Monthly and seasonal overview of the climate characteristics and record-breaking air temperature and precipitation observed in 2019

Jnauary – 6th wettest January for Serbia, 2nd wettest for Smederevska Palanka and Negotin. Valjevo, Kragujevac and Pozega observed record-breaking number of days with precipitation for January. Record low number of days with insolation in Kragujevac. Highest number of cloudy days[8] in Cuprija and Dimitrovgrad.

Febuary – February air temperature above the average. Very dry February for Vranje, dry on Palic, Novi Sad, Zrenjanin, Kurusmlija, Zajecar and Dimitrovgrad. Valjevo observed record-breaking precipitation sum. Heat waves on Palic, Kikinda and Negotin.

March – 5th warmest and 6th driest March for Serbia. 3rd warmest for Sombor, Loznica and Belgrade. Driest March for Palic, Crni Vrh and Sombor, 2nd driest for Vranje. Mean maximum monthly air temperature was exceeded on Palic, Sombor, Novi Sad, Veliko Gradiste and Negotin.

April - 4th wettest April for Sremska Mitrovica. Daily precipitation maximum surpassed in Sremska Mitrovica.

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[6] Cold wave, based on the percentile method, is defined as the period during which the minimum daily air temperature falls under the very cold and extremely cold category for 5 consecutive days and longer

[7] Heat wave, based on the percentile method, is defined as the period during which the maximum daily temperature falls under the category of very warm and extremely warm for 5 consecutive days and longer

[8] Cloudy day is a day with average daily cloud cover of more than 8/10

May - 8th coldest and 6th wettest May for Serbia. Wettest on record for Zrenjanin, 2nd wettest for Palic, Kikinda and Valjevo. Kikinda observed record-breaking number of days with precipitation in May.

June – **Warmest** June for Serbia since 1951 based on **the minimum air temperature.** 3rd warmest June for Serbia based on the mean air temperature. 6th wettest June for Sombor. Pozega observed record-breaking daily precipitation sum. Heat wave on Zlatibor lasted for 5 days.
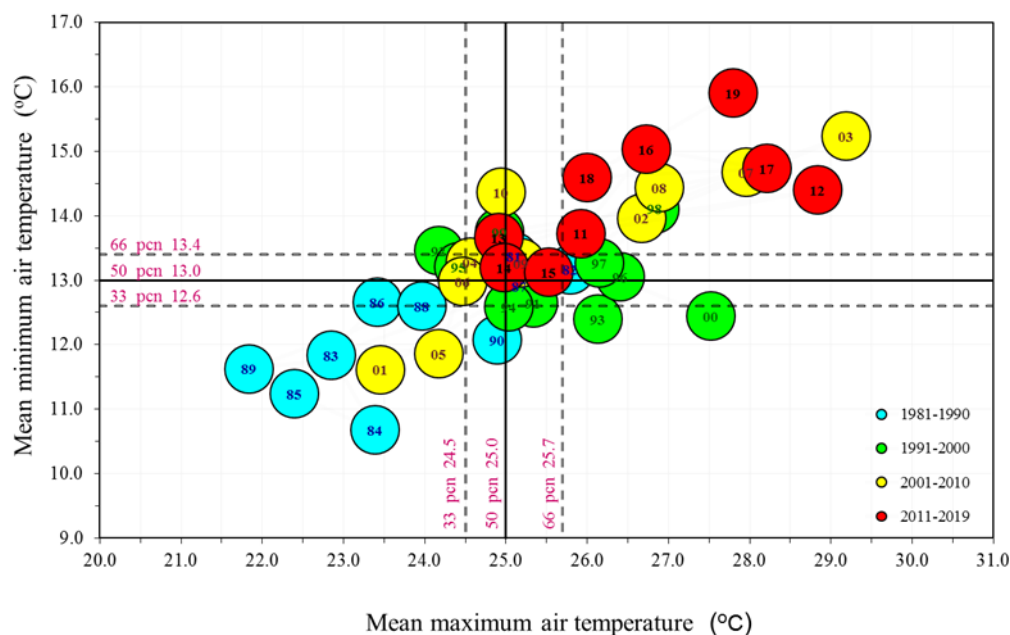

Figure 6. Mean minimum and mean maximum air temperature and their accompanying terciles for Serbia for the 1981-2019 period

July – Averagely warm and averagely rainy July in most of Serbia.

August – 8th warmest August for Serbia. 3rd warmest August for Belgrade, 4th warmest for Kikinda, Cuprja and Kopaonik, 5th warmest for Crni Vrh. Heat wave was recorded in most of the country. 5th driest August for Kragujevac, Sjenica and Zlatibor, 6th driest for Crni Vrh and Negotin.

September – In most of the country, warm and dry September. 2nd driest September for Krusevac, 4th driest for Cuprija since the record-keeping began. Heat wave, lasting for 5 days, was record in Kraljevo and Pozega.

October – **Warmest** October for Serbia since 1951 based on the maximum air temperature. Warmest October based on the maximum air temperature at 12 MMS since the record-keeping began. 4th warmest October for Serbia since 1951 based on the mean air temperature. Warmest October based on the mean air temperature at Crni Vrh, Zlatibor and Kopaonik since the record-keeping began. Heat wave was recorded in the entire country lasting from October 12 to 28, which makes it the heat wave with the longest duration in most of the country, in

Belgrade it lasted for 17 days. Number of summer days was surpassed at 12 MMS since the record-keeping began. 11th driest October for Serbia since 1951. 2nd driest October at Kopaonik, 4th driest for Kursumlija since the record-keeping began. Lowest October cloud cover was recorded at Crni Vrh, Zlatibor, Sjenica, Kraljevo, Kopaonik and Krusevac record-keeping began. October maximum of number of bright days was exceeded at 11 MMS. Maximum number of insolation hours was surpassed in Smederevska Palanka, Kopaonik, Krusevac since the record-keeping began.

Zlatibor

ranking - year - Tmean anomaly (ºC) relative to 1981-2010 - Tmean
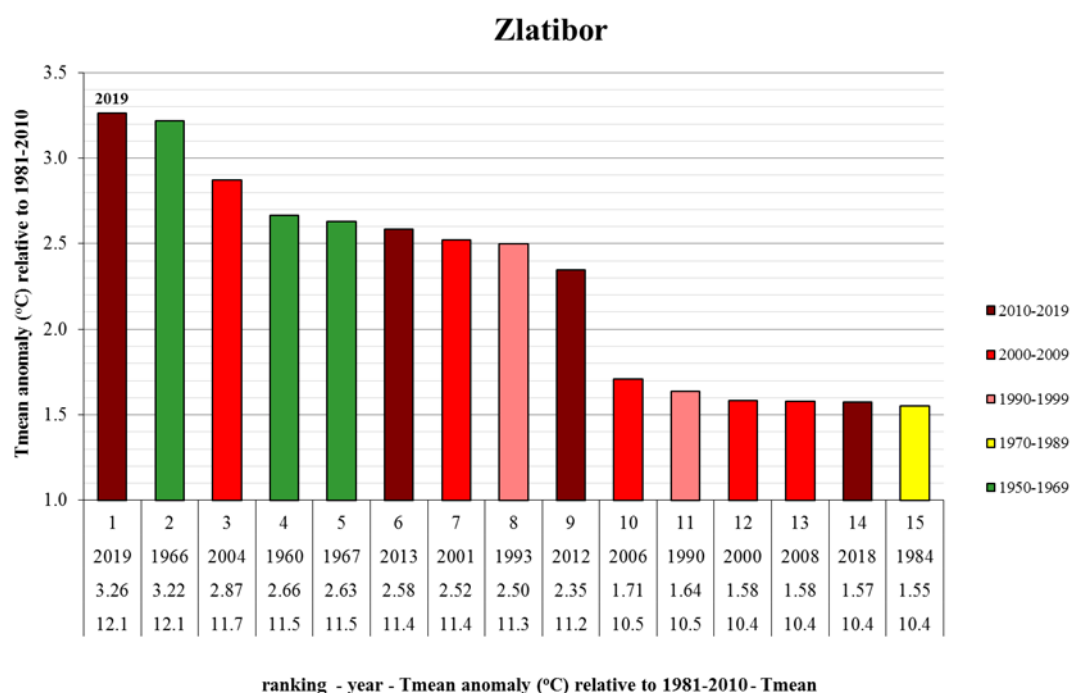
Figure 7. Warmest October in Zlatibor

ChartТабела 1. Maximum values of mean October air temperature

main station	Mean maximum air temperature October 2019	Previous record	Year of the previous record
Kikinda	**22.3**	22.0	1966
B.Karlovac	**23.0**	21.7	2018
C.Vrh	**16.6**	15.3	1967
Zlatibor	**18.6**	17.7	2001
Sjenica	**20.1**	19.4	2012
Pozega	**22.5**	21.6	1966
Kopaonik	**13.9**	12.7	2001
Kursumlija	**23.6**	22.7	1966
Krusevac	**24.1**	23.7	1935
Cuprija	**24.1**	22.3	1966
Leskovac	**23.85**	23.84	1966
Dimitrovgrad	**23.4**	22.4	2012

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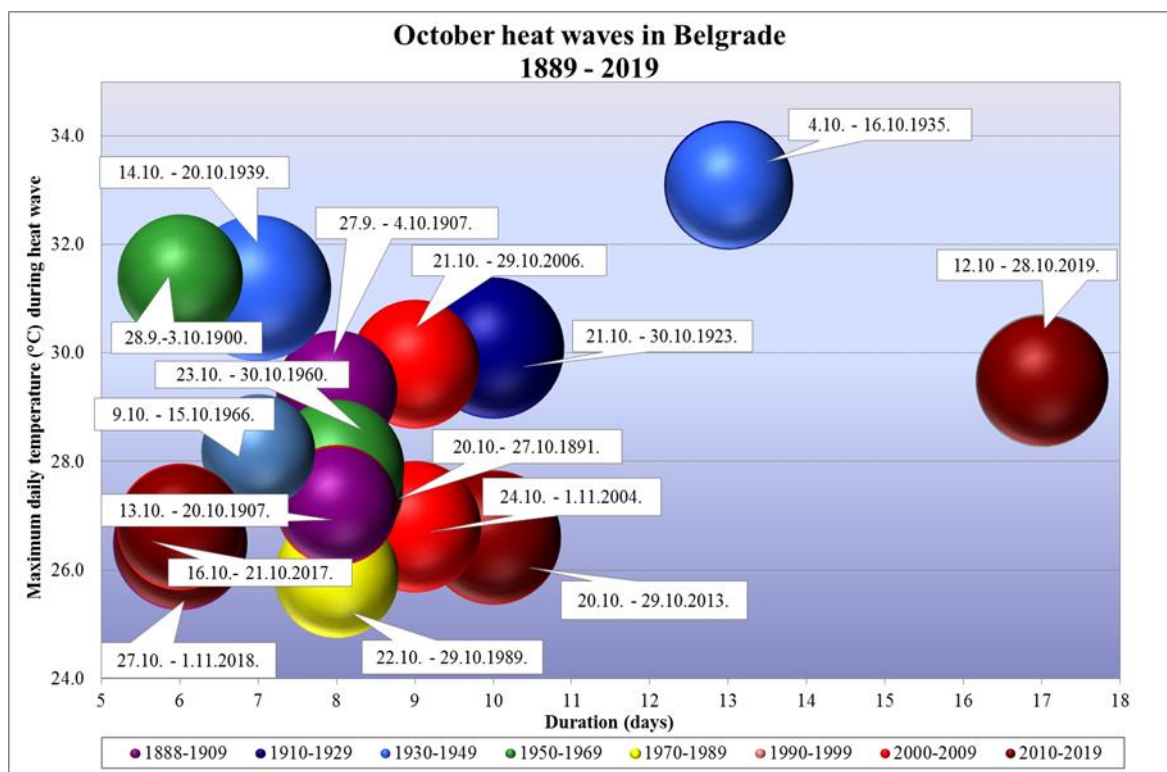
Figure 8. Rank of the 15 longest heat waves in Belgrade

November – **Warmest** November for Serbia since 1951. Mean minimum air temperature in November highest since the record-keeping began for most of Serbia. Precipitation sums were within the average across most of Serbia. 7th wettest November at Crni Vrh. Heat wave was recorded in Negotin and Vranje. Record low insolation hours at Crni Vrh and Negotin since the measurements began.

Figure 9. Rank of the warmest and coldest November for Serbia for the 1951-2019 period

December – 6th warmest December for Serbia since 1951. 4th warmest December for Zrenjanin, Crni Vrh and Cuprija, 5th warmest for Bel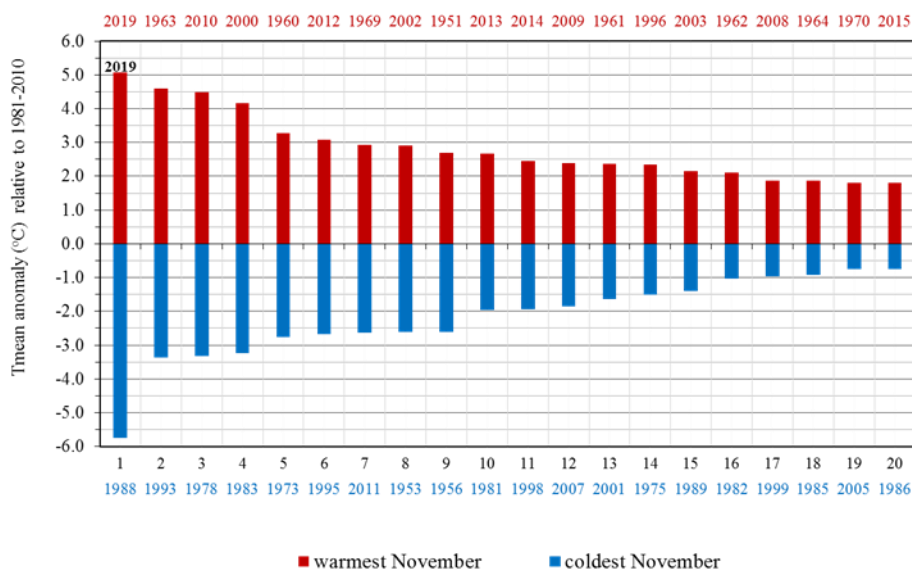grade, Palic, Kikinda and Veliko Gradiste. Kopaonik observed record-breaking number daily air temperature. Heat wave was recorded in most of the country. 2nd wettest December for Kopaonik since 1980.

Winter 2018/19 – Wet and averagely cold. At Kopaonik, 2nd wettest based on the seasonal precipitation sums. Precipitation totals in central and southern parts of Serbia was above the average, and in northernmost areas below the average.

Spring 2019 – Spring air temperature and precipitation sums above average. Number of summer days[9] significantly below the average number for spring season. 4th wettest spring for Zrenjanin and Pozega, 6th driest for Kursumlija since the record-keeping began.

Summer 2019 – Warm and averagely rainy summer. 5th warmest summer for Serbia, 3rd warmest for Palic. 2nd warmest summer for Serbia based on the minimum air temperature. During summer 2019, there were 73 days with the feels like temperature (THI[10]) above 30 degrees, which is 6 days above the summer 2017 that ranked as the 2dn warmest since 1951 up to date. Most of Serbia experienced heat wave in a period from August 23 to September 2.
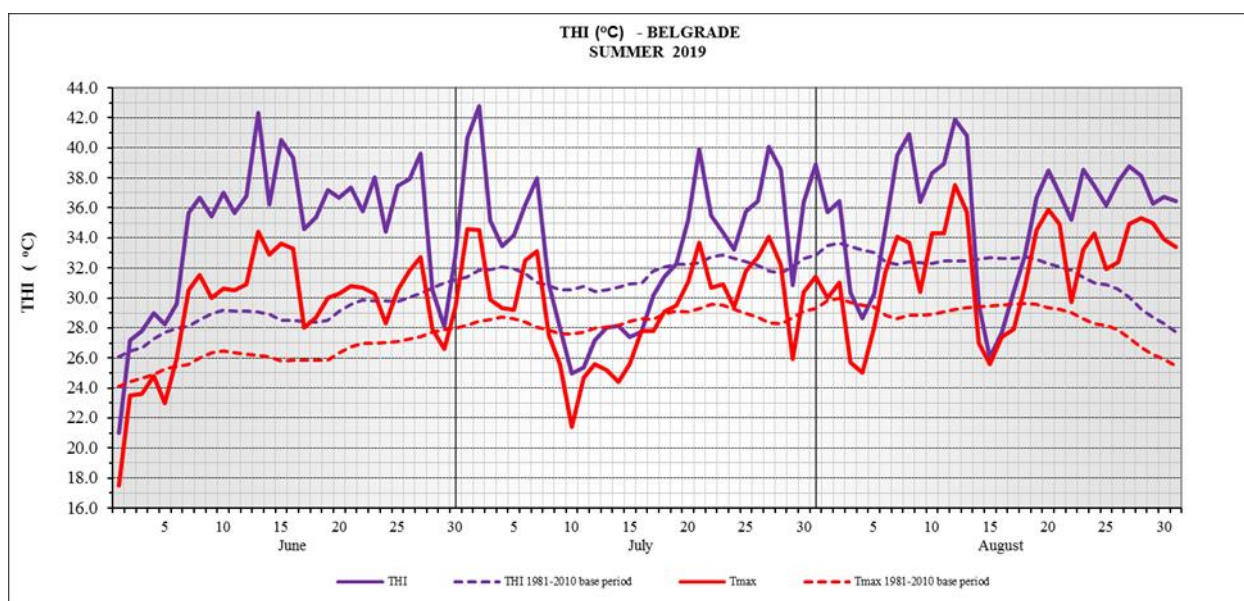
Figure 10. THI and maximum air temperature for Belgrade for summer 2019

Autumn 2019 – Warmest and 11th driest autumn for Serbia since 1951 up to date. Autumn 2019 ranks as the **warmest for Belgrade since 1887,** and at 20 MMS warmest autumn since the record-keeping began. Record high number of summer days (at 15 MMS) and record low

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[9] Летњи дан је дан са максималном дневном температуром ваздуха од 25°C и више

[10] Индекс топлотног стреса (THI) јесте мера субјективног осећаја топлоте, односно мера релативног дискомфора при дужем излагању људског тела утицају екстремно топлог и влажног времена, који показује вероватноћу топлотног удара, сунчанице или друге акутне симптоме стреса тела

number of frost days (at 17 MMS) since the measurments began. Autumn 2019 ranks as the 3rd driest for Valjevo, and 4th driest for Krusevac and Zlatibor.

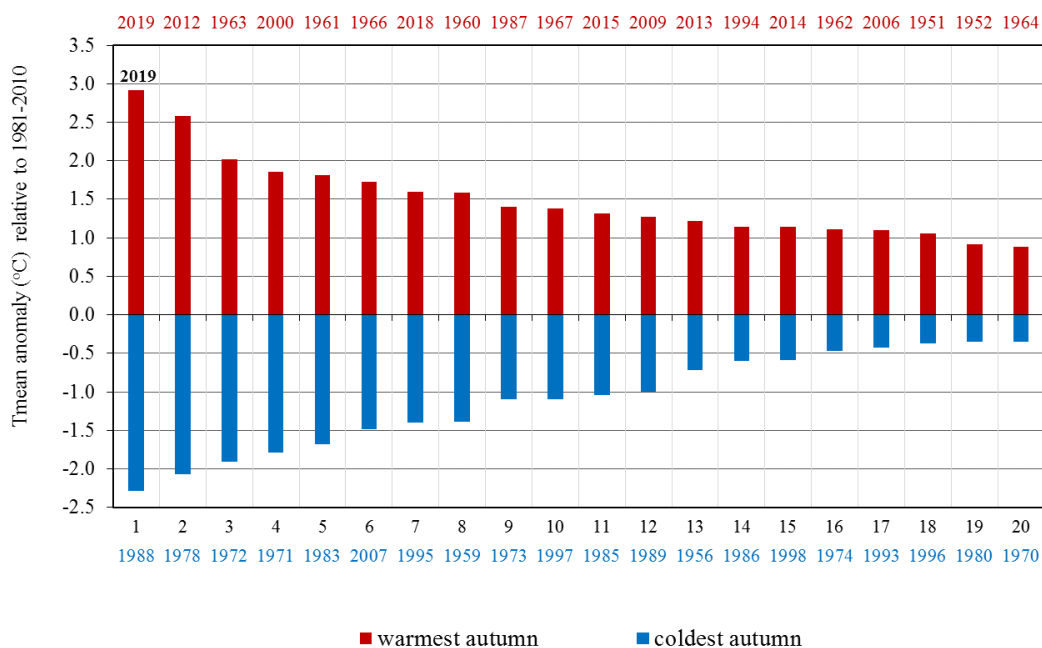Figure 11. Rank of the warmest and coldest years for Serbia for the 1951-2019 base period

*Note: Climate analysis of the meteorological elements was performed based on the preliminary data obtained from 28 main meteorological stations.

Appendix

Chart 2.

MEAN MONTHLY AND ANNUAL AIR TEMPERATURE (°C)													
station/month	January	February	March	April	May	June	July	August	September	October	November	December	Year
PALIC	0.2	4.5	9.4	13.3	15.0	23.4	23.0	24.0	17.7	12.9	9.8	4.0	13.1
SOMBOR	0.2	4.2	9.3	13.0	14.4	23.2	22.6	23.2	17.5	12.5	10.1	4.1	12.9
NOVI SAD	-0.2	4.2	9.8	13.5	14.7	23.2	23.3	24.3	18.2	13.8	11.1	4.6	13.4
ZRENJANIN	-0.2	4.3	9.7	13.2	14.8	23.3	22.9	24.5	18.6	14.3	11.3	4.8	13.5
KIKINDA	-0.3	4.1	9.4	13.2	15.1	23.3	22.5	24.5	18.2	13.7	10.7	4.2	13.2
B.KARLOVAC	-0.5	3.9	9.6	13.4	15.3	22.9	22.2	23.4	18.3	14.1	11.2	4.8	13.2
LOZNICA	0.7	4.8	10.0	13.2	14.7	22.8	22.7	24.0	18.0	14.1	11.3	5.2	13.5
S.MITROVICA	-0.3	3.8	8.8	13.3	14.8	22.9	22.3	23.3	17.4	13.2	10.8	4.1	12.9
VALJEVO	0.2	4.4	9.5	13.6	14.4	23.0	22.8	24.4	18.6	14.0	11.3	4.7	13.4
BELGRADE	0.8	5.6	11.4	14.2	15.6	24.2	24.3	26.2	20.2	16.1	12.4	6.0	14.7
KRAGUJEVAC	-0.1	4.2	9.1	13.2	14.5	22.4	22.3	23.7	18.3	13.6	11.7	4.9	13.2
S.PALANKA	-0.2	4.3	9.4	13.4	14.7	23.0	22.7	24.1	18.6	13.6	11.6	4.8	13.3
V.GRADISTE	-0.3	3.6	9.5	13.2	14.9	22.9	22.7	23.9	18.8	14.3	11.7	4.7	13.3
CRNI VRH	-4.6	-0.7	5.1	6.8	9.6	17.6	17.7	20.0	14.4	11.8	5.3	1.2	8.7
NEGOTIN	0.9	4.5	10.5	12.8	16.8	23.6	24.3	25.3	20.2	13.1	9.5	4.3	13.8
ZLATIBOR	-3.7	0.1	5.0	8.6	9.6	18.5	17.9	20.2	14.7	12.1	8.3	1.5	9.4
SJENICA	-4.4	-1.3	3.9	7.7	9.5	17.2	16.8	17.8	13.2	8.6	7.3	0.4	8.1
POZEGA	-2.2	1.9	7.1	11.7	13.1	20.7	20.2	21.2	15.9	11.3	8.6	1.8	10.9
KRALJEVO	-0.6	4.2	9.5	13.2	14.5	22.6	22.5	23.8	18.5	14.1	11.8	3.8	13.2
KOPAONIK	-6.8	-3.9	0.4	3.6	5.2	13.6	13.4	15.3	10.5	8.4	3.6	-1.5	5.2
KURSUMLIJA	-0.4	3.2	8.1	11.8	13.8	20.6	20.7	21.3	16.7	12.7	10.4	4.1	11.9
KRUSEVAC	-0.3	4.2	9.2	12.9	15.0	22.6	22.6	23.0	18.5	13.6	12.0	4.5	13.2
CUPRIJA	-0.2	3.6	9.0	13.2	15.2	22.8	22.6	24.0	18.6	13.7	11.7	4.7	13.2
NIS	-0.2	4.1	10.1	13.7	15.3	22.9	23.3	24.5	19.1	14.7	12.1	4.8	13.7
LESKOVAC	-0.6	3.4	9.0	13.2	14.7	22.1	22.5	23.3	17.6	12.7	11.1	4.1	12.8
ZAJECAR	0.1	2.8	8.5	11.9	15.0	21.6	22.1	22.5	17.5	12.0	9.2	3.6	12.2
DIMITROVGRAD	-0.8	2.3	7.4	11.1	13.6	19.9	21.2	21.6	16.8	13.0	10.6	3.6	11.7
VRANJE	-1.3	3.5	9.4	12.6	14.3	21.4	22.3	23.8	18.6	14.4	11.6	3.5	12.8

extremely cold	very cold	cold	normal	warm	very warm	extremely warm
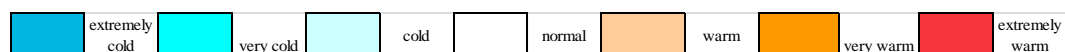
Chart 3.

MONTHLY AND ANNUAL PRECIPITATION SUMM (mm)													
station/month	January	February	March	April	May	June	July	August	September	October	November	December	Year
PALIC	34.1	14.1	1	27.2	163.9	100.8	39.4	37.8	65.4	24.7	59.3	38.8	606.5
SOMBOR	44.2	23.1	1.7	41.3	114.6	155.4	67.6	53.1	52.8	37.7	60.1	47.6	699.2
NOVI SAD	45.8	17	15.9	54.1	147.5	63.7	21	79.1	53.1	20	53.7	61.1	632
ZRENJANIN	49.9	11.8	7.3	60.6	177.9	119.5	18	41.4	32.9	16.5	53.3	39.4	628.5
KIKINDA	42.7	13.5	10.8	21.6	207.9	115.8	22.6	18.4	45.1	14.9	49.2	32.9	595.4
B.KARLOVAC	74.8	26.6	3.1	63.1	120.7	117.5	97.6	23.3	24.8	12.8	41.2	44	649.5
LOZNICA	77	48.6	37.8	96.3	124.4	137.1	81.4	28.3	44.2	33.3	55	82.4	845.8
S.MITROVICA	49.1	21.1	8.1	102.8	131.1	108.7	38.3	47.1	43.3	20.5	48.8	43.9	662.8
VALJEVO	74.3	55.4	19.7	46.6	218.3	88.2	54	36.4	16.8	23.8	31.8	75.8	741.1
BELGRADE	81.8	33.7	11.5	76.8	142.2	138.7	43	39.7	26.1	13.3	54.3	55.3	716.4
KRAGUJEVAC	85.3	42.2	10	35.2	125.3	143	83.2	8.3	32	19.6	68.1	57.6	709.8
S.PALANKA	94.1	33	13.8	68.7	122.5	92.5	33.3	35.3	14.1	23.2	39	46.4	615.9
V.GRADISTE	86.4	23.3	5.3	62.6	139	95.1	54	27.9	25.6	9.6	43.9	55.5	628.2
CRNI VRH	77.5	24.1	8	75.3	137.1	82.5	98.1	17.5	37	35	104.5	43.1	739.7
NEGOTIN	112.4	17.6	4.8	64.3	72.5	85.2	55	1.3	8.7	31.1	96.8	19.2	568.9
ZLATIBOR	95.4	65.1	30.5	111.3	109.8	85.3	105.8	16.6	36.8	27.9	52.7	80.2	817.4
SJENICA	68.7	40.1	31.8	57.9	84.4	126.8	89.1	9.3	52.6	24.8	85.1	48	718.6
POZEGA	66.4	43	25.7	101.9	175.2	110.5	80.8	68	22.6	32.6	48.9	80.1	855.7
KRALJEVO	88.2	60.9	26.2	60.5	102.8	163.4	26.5	48.9	9.2	13.7	62.2	54.1	716.6
KOPAONIK	135	86.7	31.6	110.9	150.2	167.5	83	71.3	48.8	12.8	109.4	145.1	1152.3
KURSUMLIJA	95	22.8	13.2	38.5	45.4	112.9	81.4	42.3	29.3	2.3	56.8	40.3	580.2
KRUSEVAC	97.5	37.2	24.1	59.2	73.5	68	47.1	83.1	4.8	5.5	47.1	41.4	588.5
CUPRIJA	104.9	40.7	16.9	48.3	131.3	124	53.5	20.5	5.7	12.2	51	75	684
NIS	88.7	26.4	11.7	36.4	100.5	29.9	82.3	31.7	19.3	4.3	43.2	41	515.4
LESKOVAC	79.4	28.3	7.8	38.4	97.9	124	68.6	20.3	22.8	8.1	41.6	52.7	589.9
ZAJECAR	84.7	14.6	9.7	43.6	98.2	93.7	107.2	22.5	20.8	10	56.9	13.6	575.5
DIMITROVGRAD	57.3	24.4	15.8	46	67.7	79.4	67.5	35	30.7	21.4	48.5	32.9	526.6
VRANJE	71.9	15.8	4.5	42.2	67.4	90	52.4	13.9	20.5	8.4	49.6	69.9	506.5

extremely dry	very dry	dry	normal	wet	very wet	extremely wet
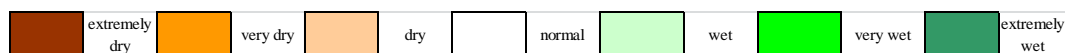
Anomaly of mean year temperature relative to 1981-2010 base period
Belgrade - 1888-2019 period
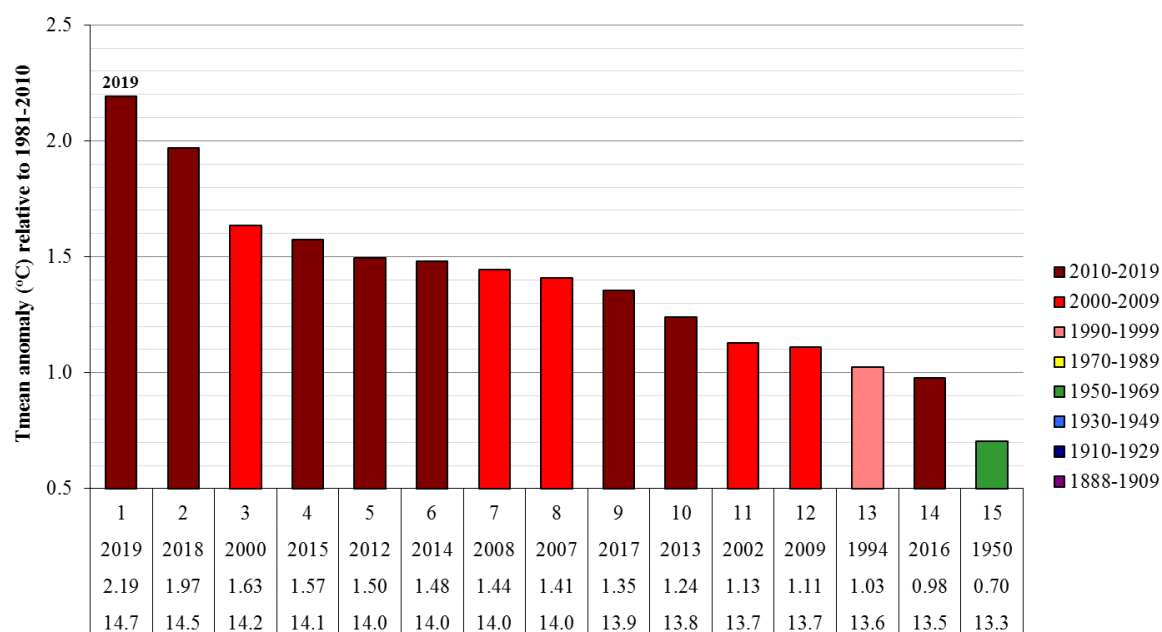
ranking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
year	2019	2018	2000	2015	2012	2014	2008	2007	2017	2013	2002	2009	1994	2016	1950
Tmean anomaly (°C) relative to 1981-2010	2.19	1.97	1.63	1.57	1.50	1.48	1.44	1.41	1.35	1.24	1.13	1.11	1.03	0.98	0.70
Tmean	14.7	14.5	14.2	14.1	14.0	14.0	14.0	14.0	13.9	13.8	13.7	13.7	13.6	13.5	13.3

ranking - year - Tmean anomaly (ºC) relative to 1981-2010 - Tmean

Figure 12. Rank of the 15 warmest years for Belgrade
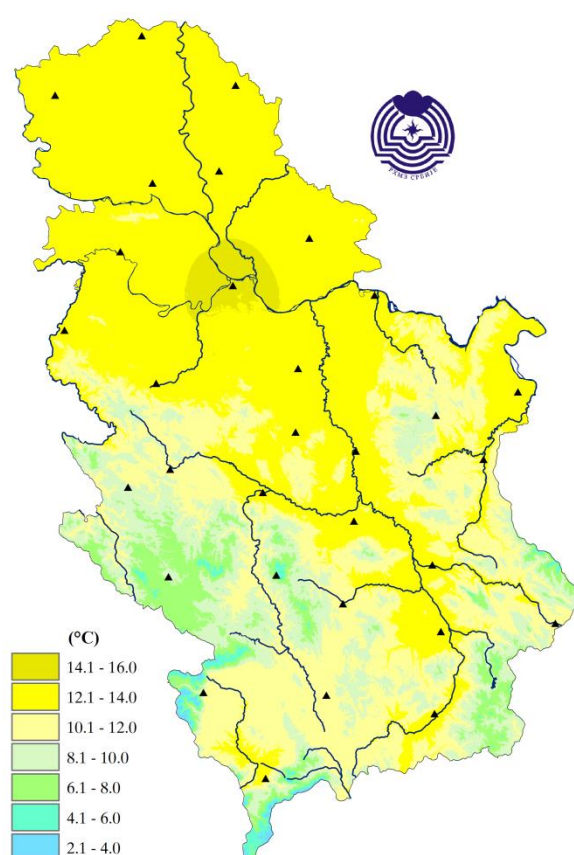
Figure 13. Spatial distribution of mean annual air temperature expressed in (°C)
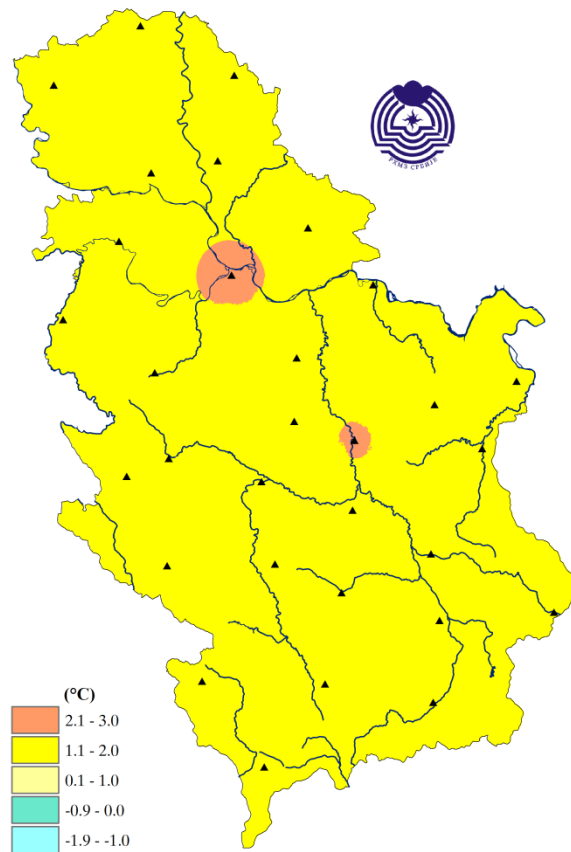
Figure 14. Spatial distribution of mean annual air temperature anomaly expressed in (°C)
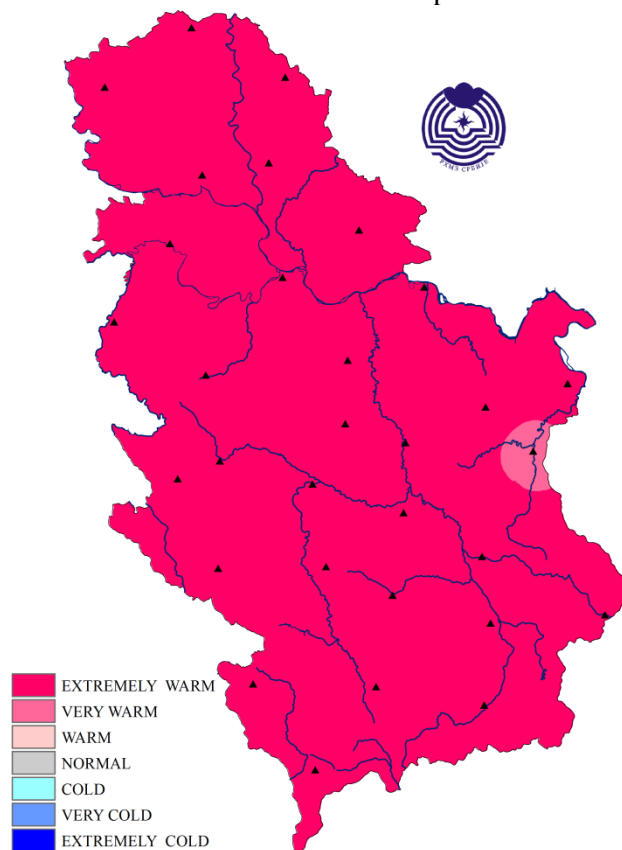
Figure 15. Spatial distribution of mean annual air temperature based on percentile method
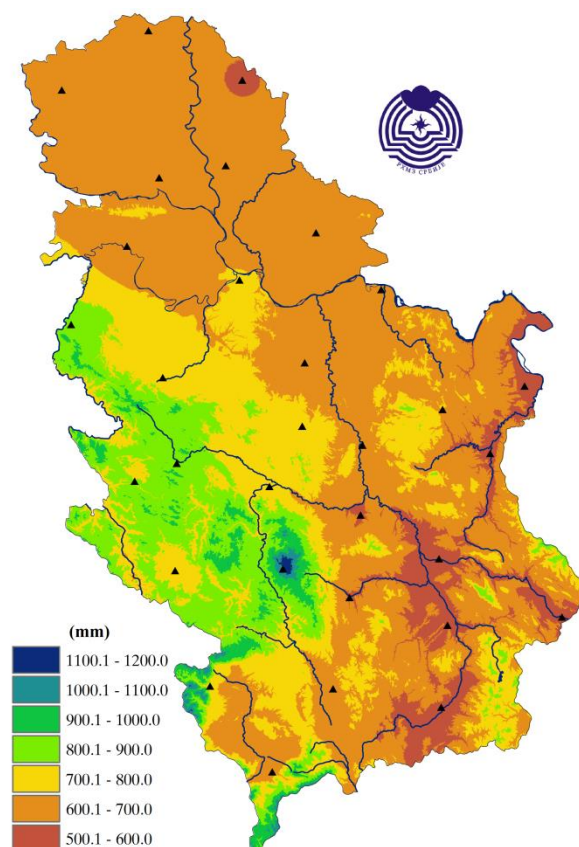
Figure 16. Spatial distribution of annual precipitation totals expressed in mm
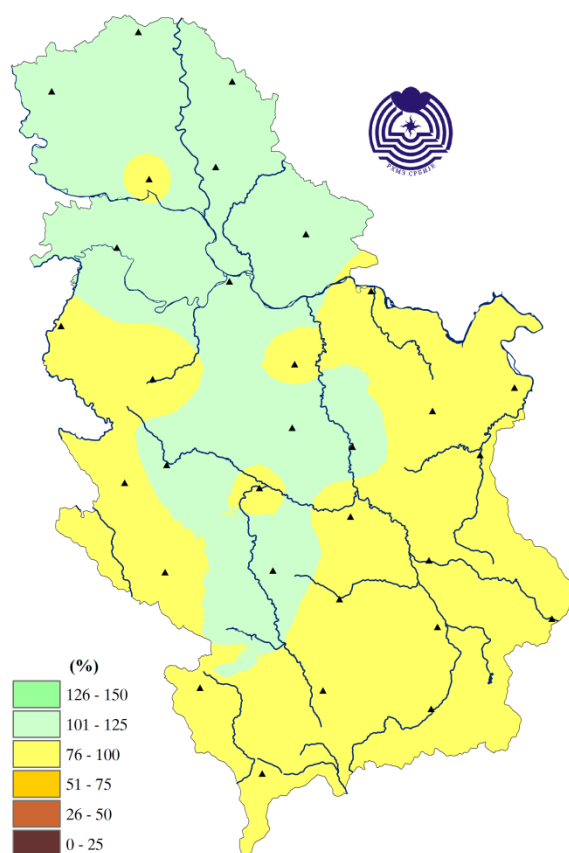

Figure 17. Spatial distribution of annual precipitation totals expressed in percentages of normal for the 1981-2010 base period
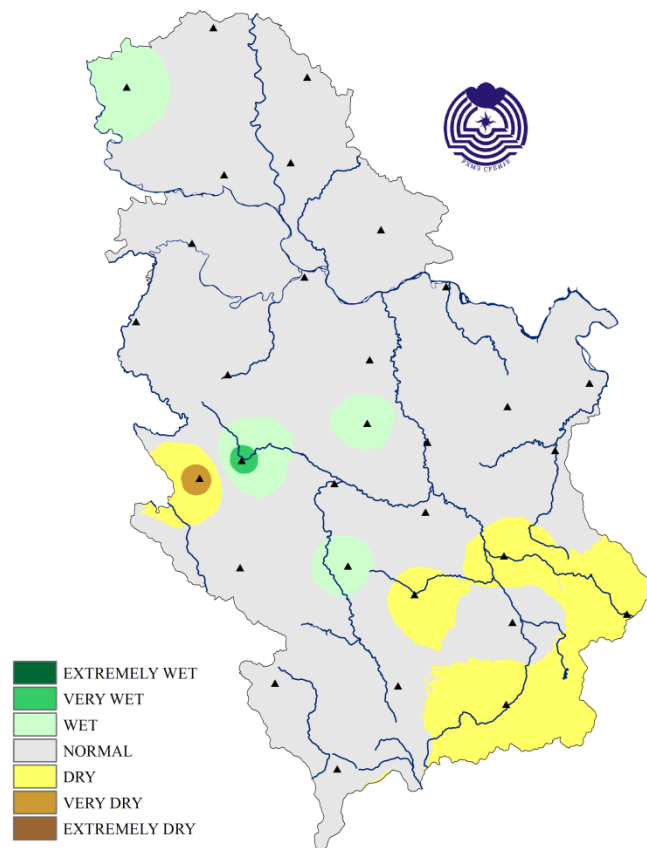
Figure 18. Spatial distribution on annual precipitation totals based on percentile method
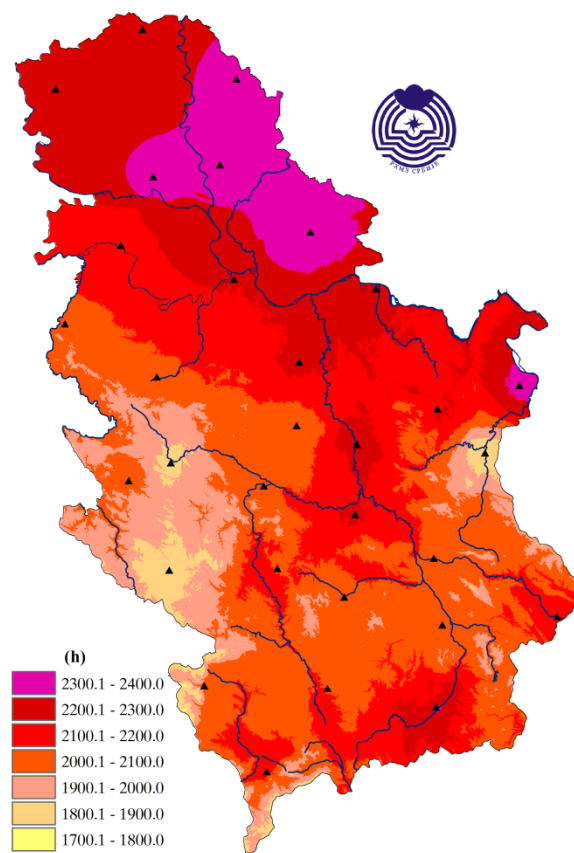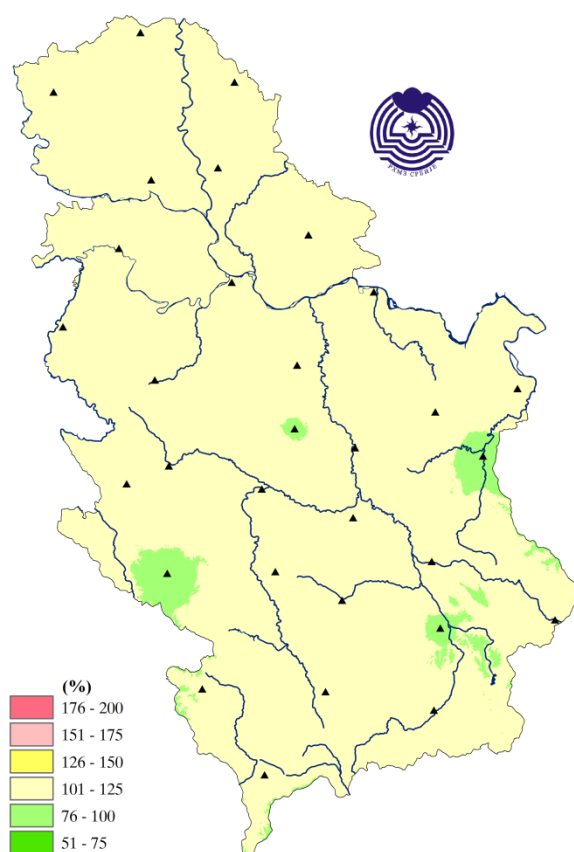

Figure 19. Insolation expressed in hours

Figure 20. Insolation expressed in percentages of normal for the 1981-2010 base period