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Climate characteristics of Serbia

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Moderate-continental and mountain climate are characteristic for the territory of Serbia

Climate of Serbia can be described as moderate-continental with more or less pronounced local characteristics. Spatial distribution of climate parameters is caused by geographic location, relief and local influence as a result of combination of relief, distribution of air pressure of major scale, terrain exposition, presence of river systems, vegetation, urbanization etc. Among geographic determinants featuring important synoptic situations significant for weather and climate of Serbia the following should be mentioned: The Alps, Mediterranean Sea and Genoa Bay, Pannonian Plain and the Morava valley, Carpathian and Rhodope Mountains, as well as hilly-mountainous areas with valleys and highland plains. Prevailing meridional location of river valleys and plains in the northern area of the country make possible the deep southward incursion of polar air masses.

The lowest temperature ever recorded since the instrumental¹ measurements commenced on the territory of Serbia was $-39,5^{\circ}\text{C}$ in Karajukica Bunarima (near Sjenica) on January 29 1987 and the highest temperature ever measured was $44,9^{\circ}\text{C}$ in Smederevska Palanka on July 24 2007.

The analysis is performed on the basis of the measurements taken at 7am, 2pm and 9pm at the principal meteorological stations (30 stations) for the latest 1981-2010 base period.

Air temperature

Mean annual air temperature across much of Serbia (at 22 principal meteorological stations) was between 11°C and 12°C (Figure 1).

The lowest mean annual air temperature was $3,7^{\circ}\text{C}$ on Kopaonik Mountain, $6,7^{\circ}\text{C}$ in Sjenica and $6,6^{\circ}\text{C}$ on Crni Vrh while the highest was $12,5^{\circ}\text{C}$ in Belgrade, $11,9^{\circ}\text{C}$ in Nis and Vrsac and $11,8^{\circ}\text{C}$ in Negotin.

Determined by climatological criteria winter begins on 1st December and ends 28th February (that is 29th February), spring begins on 1st March and ends on 31st May, summer begins on 1st June and ends on 31st August, autumn starts on 1st September and ends on 30th November.

¹ In Belgrade, instrumental measurements are dating back to 1888 and 1925 for the other principal meteorological stations

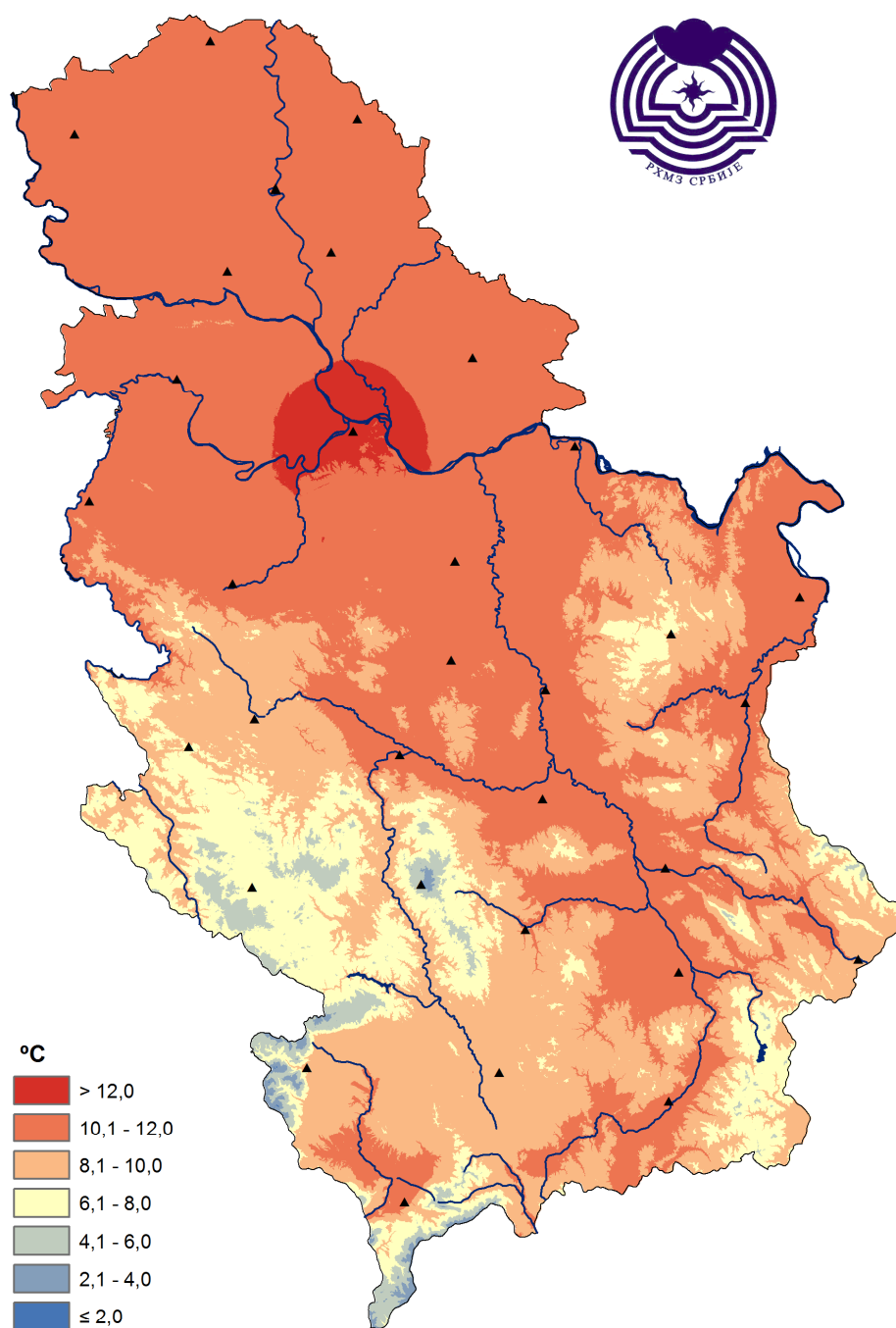
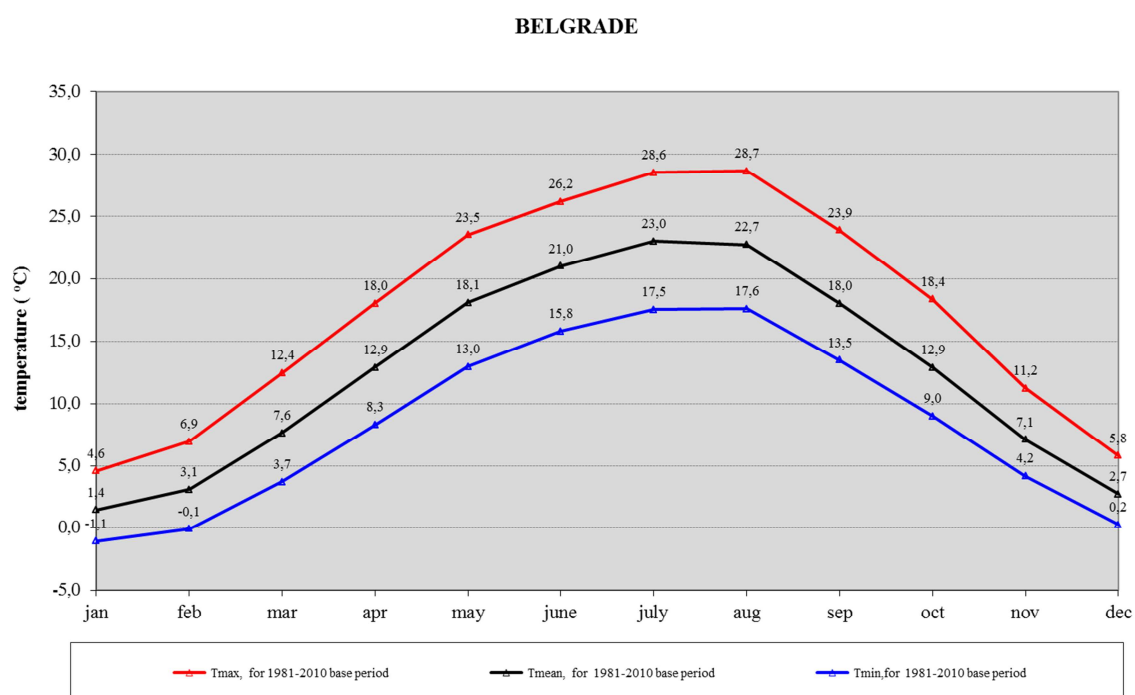


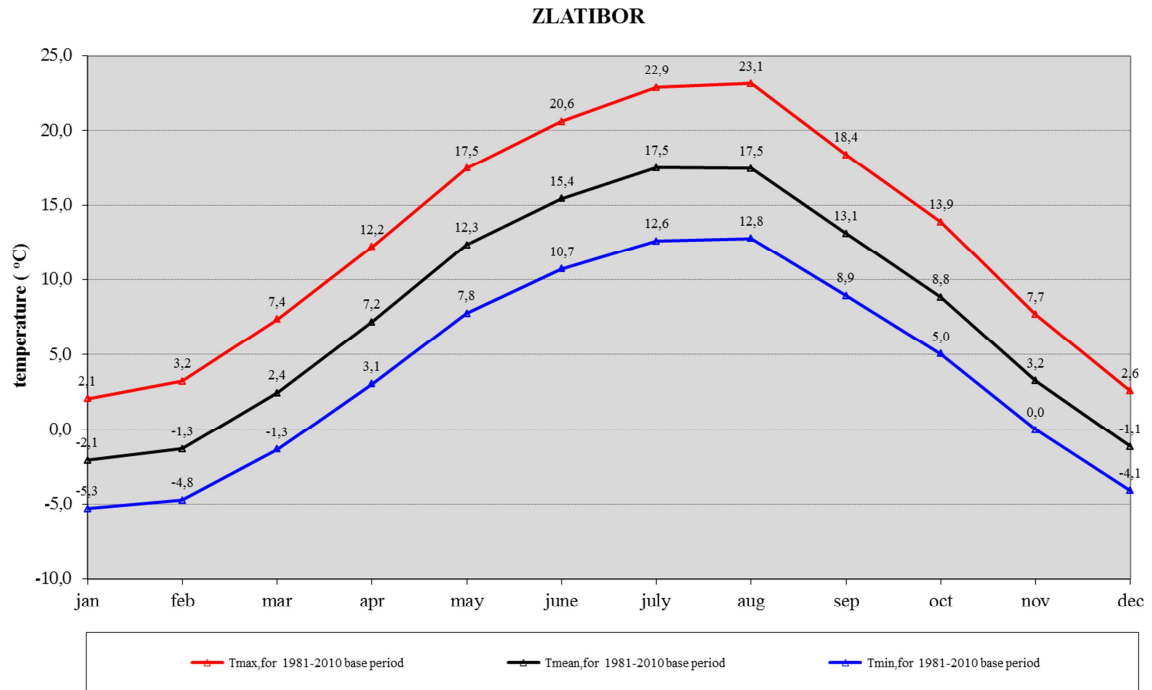
Figure 1. Mean annual air temperature for the 1981-2010 base period

All 4 seasons are equally pronounced. The warmest period is the summer with the mean seasonal temperature between 21°C and 22°C at 17 principal meteorological stations (the highest seasonal air temperature of 22,5°C was registered in Negotin and the lowest of 12°C on Kopaonik Mountain). The mean winter air temperature is below 0°C at 5 stations (the lowest temperature, measuring -4,4°C is observed on Kopaonik) whereas it is ranging between 0°C and 2°C at the remaining stations (2,4°C in Belgrade due to the fact that the urbanization impact is most pronounced during this season). The mean seasonal air temperature during spring and autumn ranges between 11°C and 12°C at 11 stations. The coldest spring is characteristic for Kopaonik Mountain (mean seasonal air temperature of 12,9°C) while the warmest autumn is in Belgrade (mean seasonal air temperature of 12,7°C) and the coldest one on Kopaonik Mountain (mean seasonal air temperature of 4,6°C).

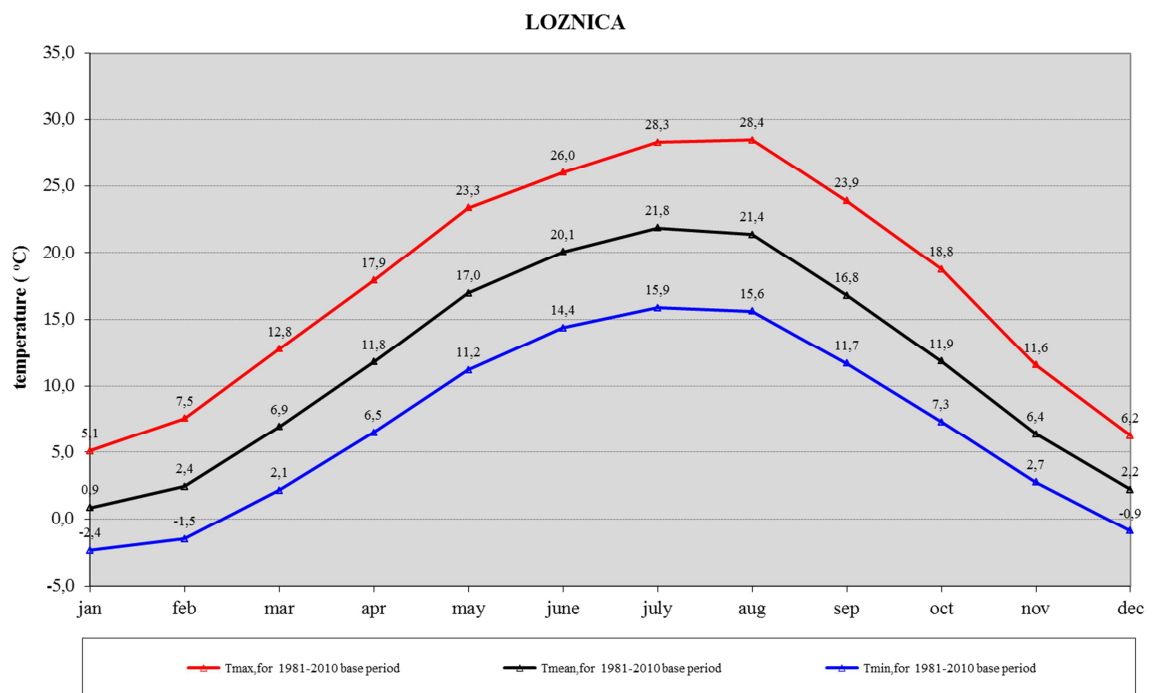
On the basis of the analysis, July is the warmest month with the mean monthly air temperature ranging between 20°C and 23°C and between 13°C and 17°C on mountains. The coldest month is January with the mean air temperature in a range between 0°C and 1°C, that is -4,5°C on the mountains. (Graphs 1 - 5).



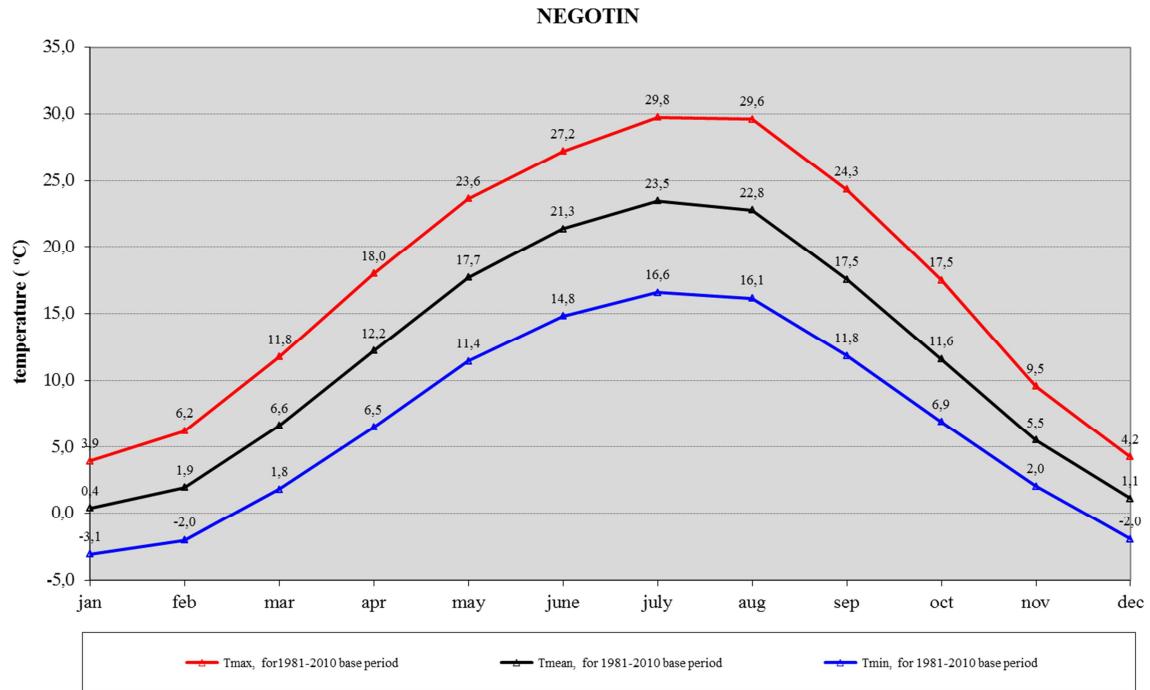
Graph 1. Maximum, minimum and mean air temperature for the 1981-2010 base period for Belgrade



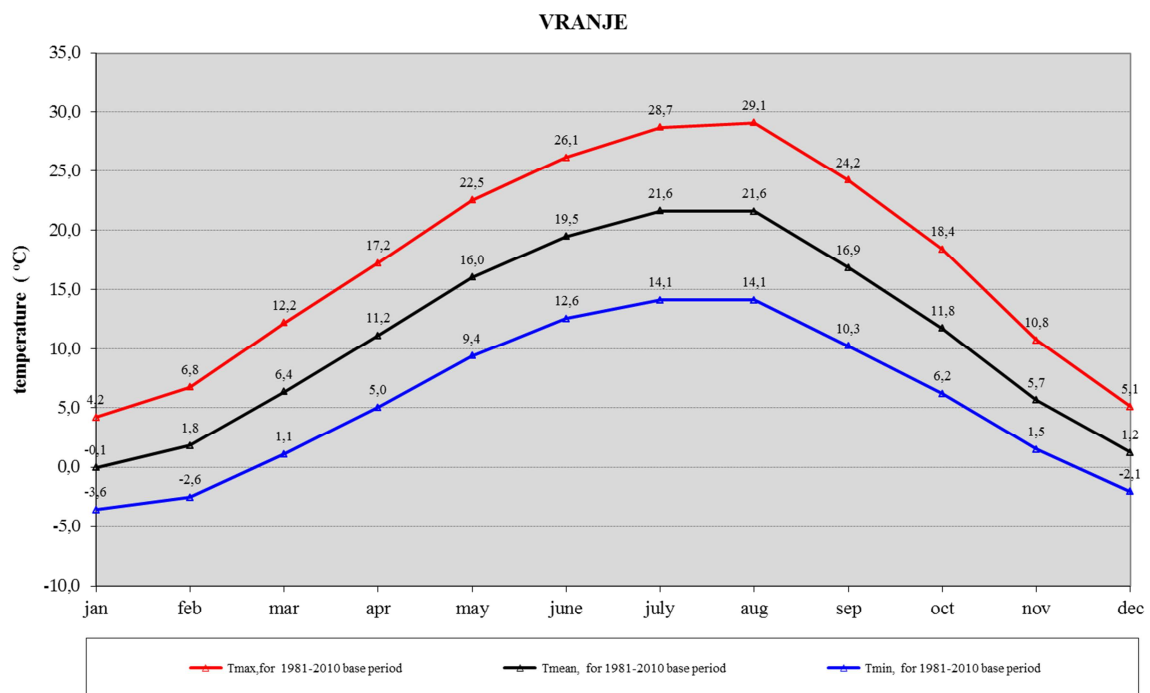
Graph 2. Maximum, minimum and mean air temperature for the 1981-2010 base period for Zlatibor Mountain



Graph 3. Maximum, minimum and mean air temperature for the 1981-2010 base period for Loznica



Graph 4. Maximum, minimum and mean air temperature for the 1981-2010 base period for Negotin



Graph 5. Maximum, minimum and mean air temperature for the 1981-2010 base period for Vranje

The maximum air temperature in the period between 1981 – 2010 at the principal meteorological stations reached 44,9°C registered in Smederevska Palanka on July 24 2007 when two third of the principal meteorological stations observed record high temperatures of 44,6°C and 44,7°C, in Curpija and Zajecar, respectively.

The lowest air temperature in the period between 1981 - 2010 at the principal meteorological stations dropped to -35,6°C observed in Sjenica on January 31 1987 and between -21°C and -31°C on the other stations.

The highest average number of tropical days², total of 49, was registered in Nis, 46 and 44 days were observed in easternmost parts, Zajecar and Negotin, respectively (Figure 2). The other principal meteorological stations saw between 30 and 40 tropical days. The average number of tropical days varies from 2 on Crni Vrh to 5 on Zlatibor and Sjenica, while Kopaonik Mountain didn't experience any. The highest number of tropical days in the period between 1981-2010 in Serbia, was registered in 2003 in Nis and it amounted to 83.

² Tropical days is defined as a day with the maximum air temperature exceeding 30 °C

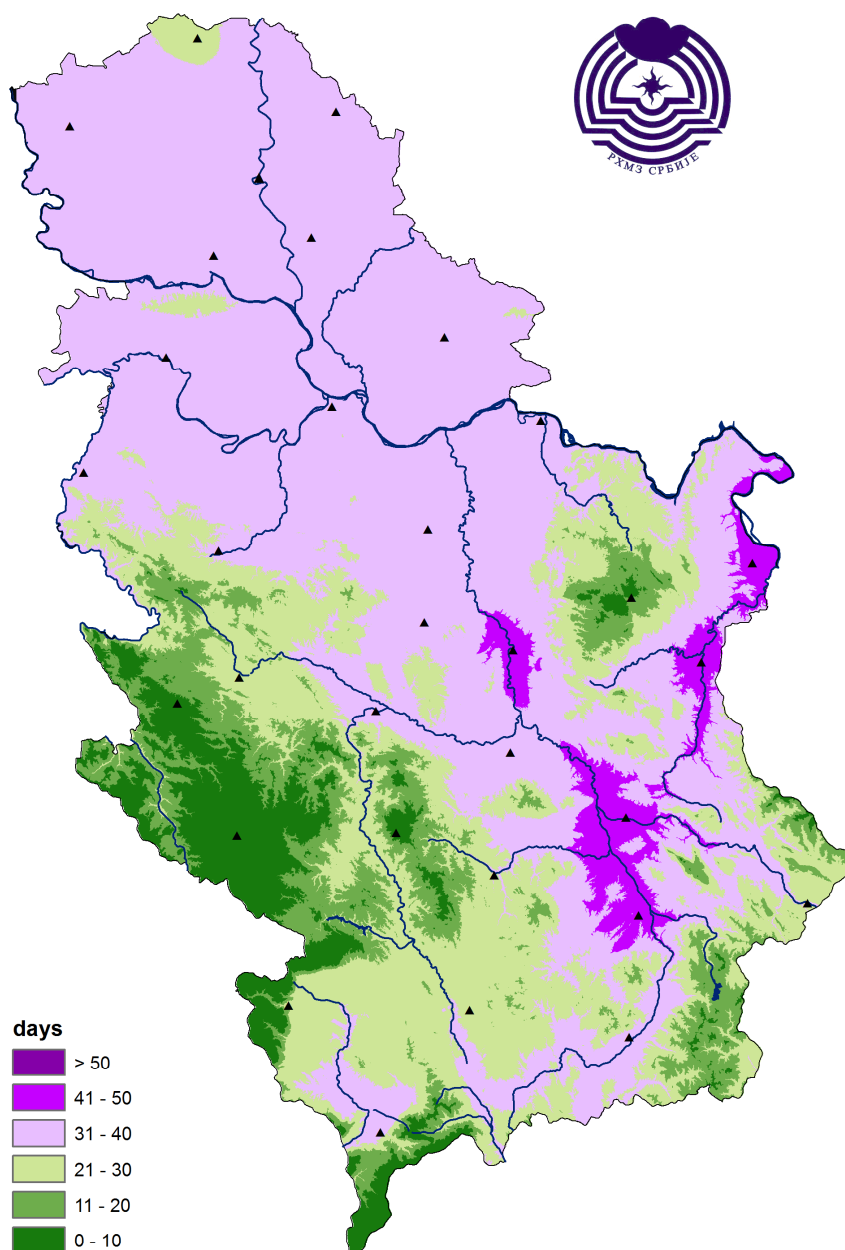


Figure 2. Average number of tropical days for the 1981-2010 base period

The highest average annual number of summer days³ recorded across Serbia was: 111 days in Nis, 109 in Zajecar, 107 in Negotin and between 90 and 100 days on the remaining principal meteorological stations. Average number of summer days varies from 2 on Kopaonik Mountain, 21 on Crni Vrh, 32 on Zlatibor Mountain to 37 in Sjenica (Figure 3). In the period between 1981-2010 in Serbia, the highest number of summer days, total of 134, was observed in Sombor in 2003.

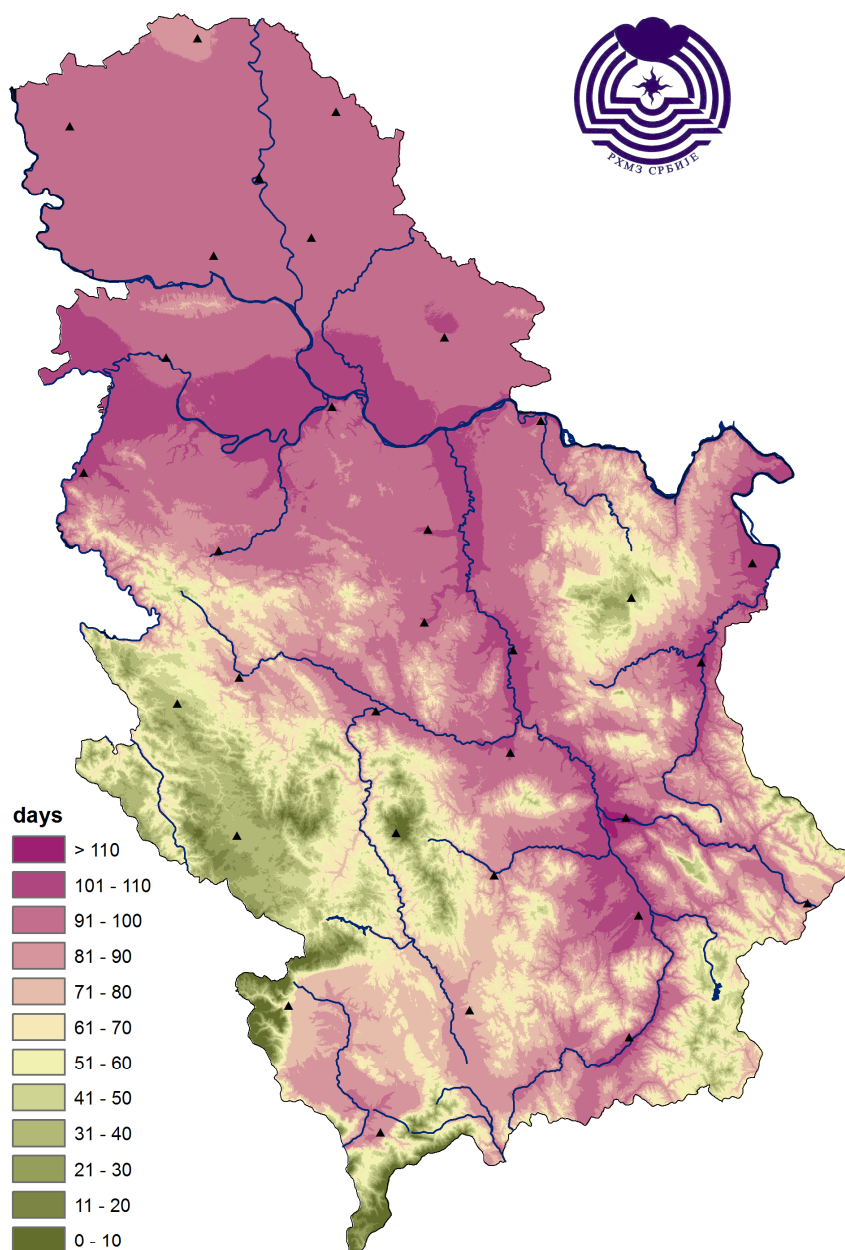
The highest average number of ice days⁴, total of 73, was registered on Kopaonik Mountain, 63 on Crni Vrh, 41 on Zlatibor, 39 in Sjenica and between 15 and 21 on the remaining principal meteorological stations (Figure 4). In the period between 1981-2010 in Serbia, the highest number of ice days, total of 97, was observed on Kopaonik Mountain in 1981.

The highest average number of frost days⁵, total of 170 was recorded on Kopaonik Mountain, 148 on Crni Vrh, 143 in Sjenica, 116 on Zlatibor Mountain and between 76 and 103 days on the other principal meteorological stations (Figure 5). In the period between 1981 - 2010 in Serbia, Kopaonik Mountain observed the highest number of frost days, total of 195 days in 1997.

³ Summer day is defined as a day with the maximum air temperature exceeding 25°C

⁴ Ice day is defined as a day with maximum air temperature below 0°C

⁵ Frost day is defines as a day with the minimum air temperature below 0°C



Average 3. Average number of summer days for the 1981-2010 base period

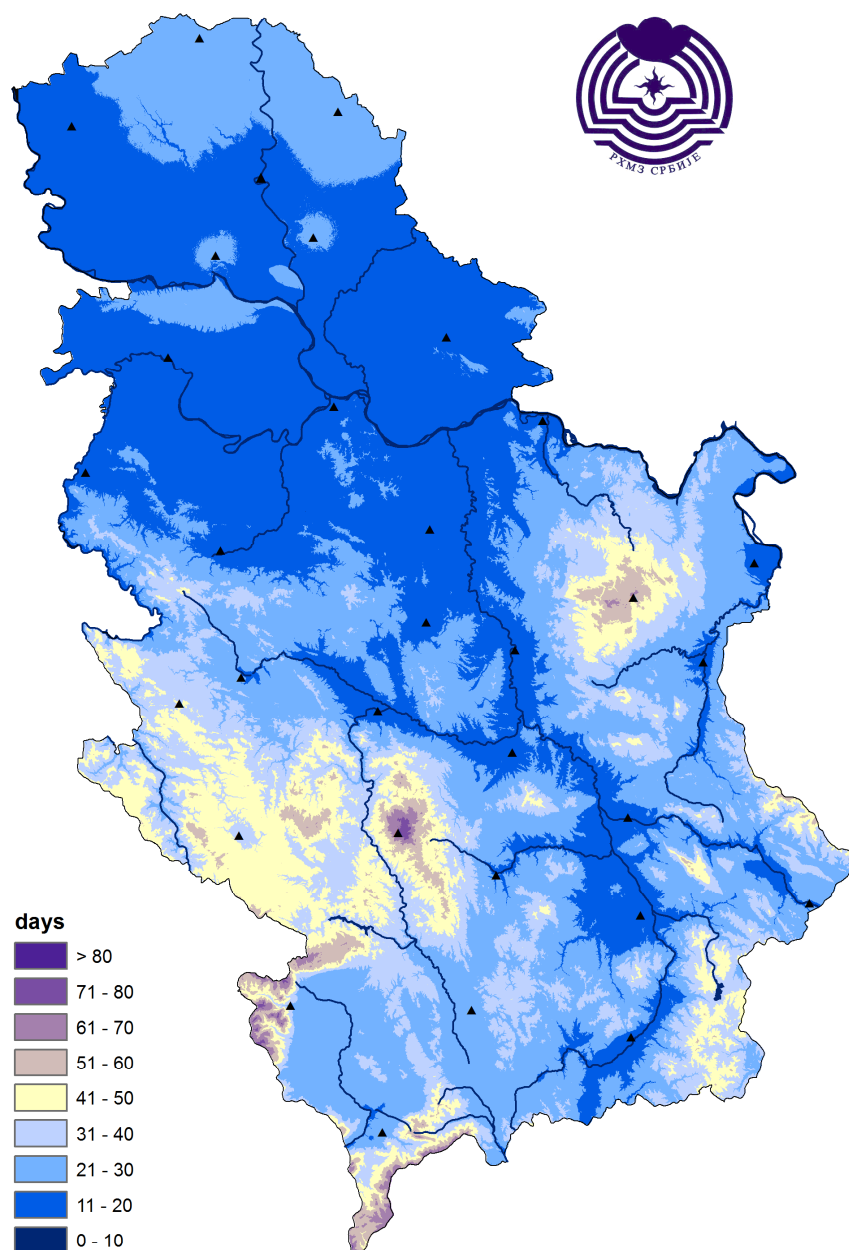


Figure 4. Average number of ice days for the 1981-2010 base period

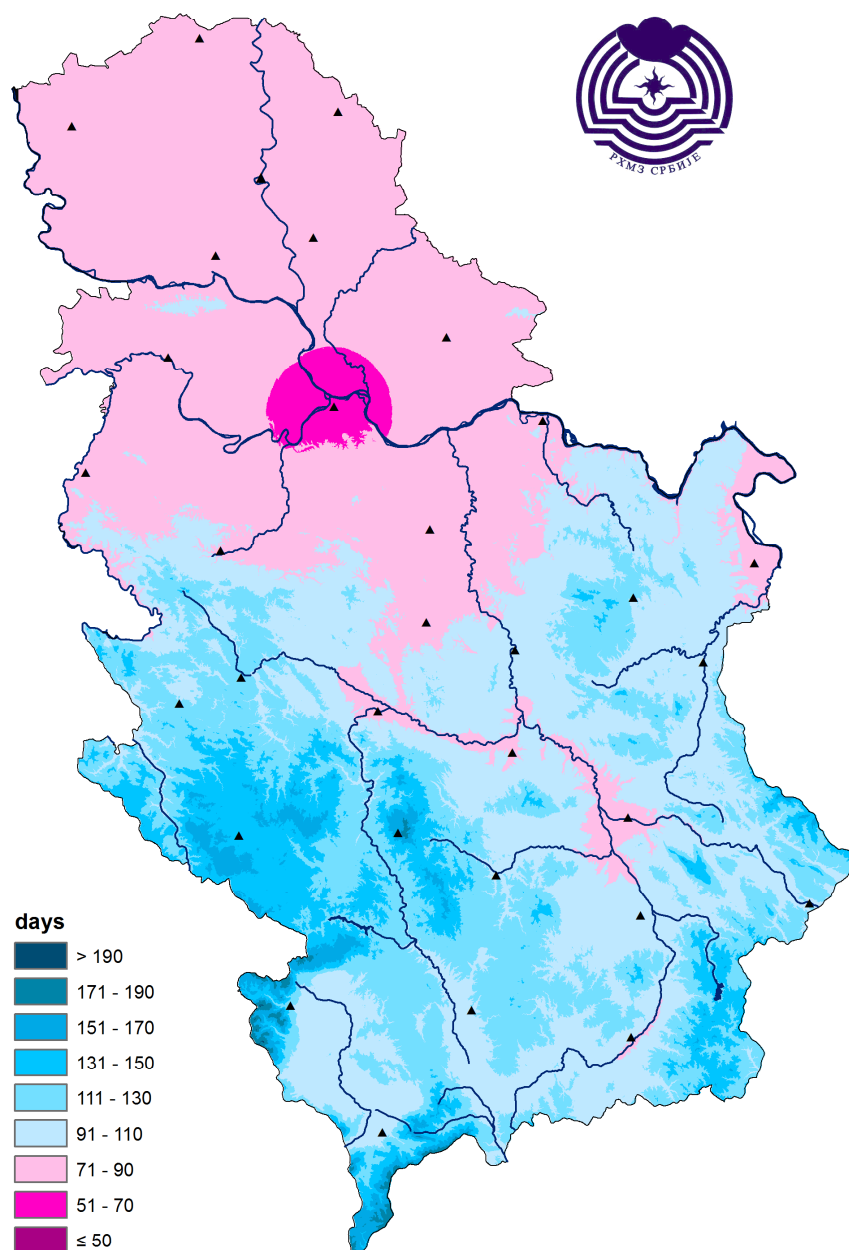


Figure 5. Average number of frost days for the 1981-2010 base period

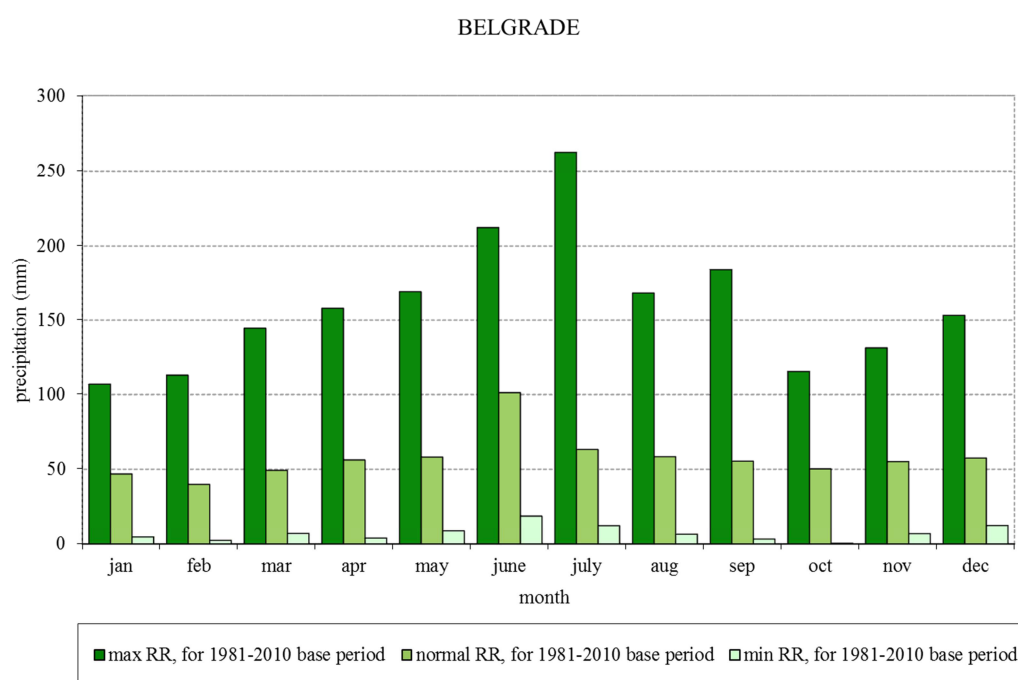
Precipitation quantity

Annual precipitation quantities increase in average with altitude. The mean annual precipitation sums across Serbia are in a range from 557 mm in Kikinda up to 1018 mm on Zlatibor Mountain (Figure 6).

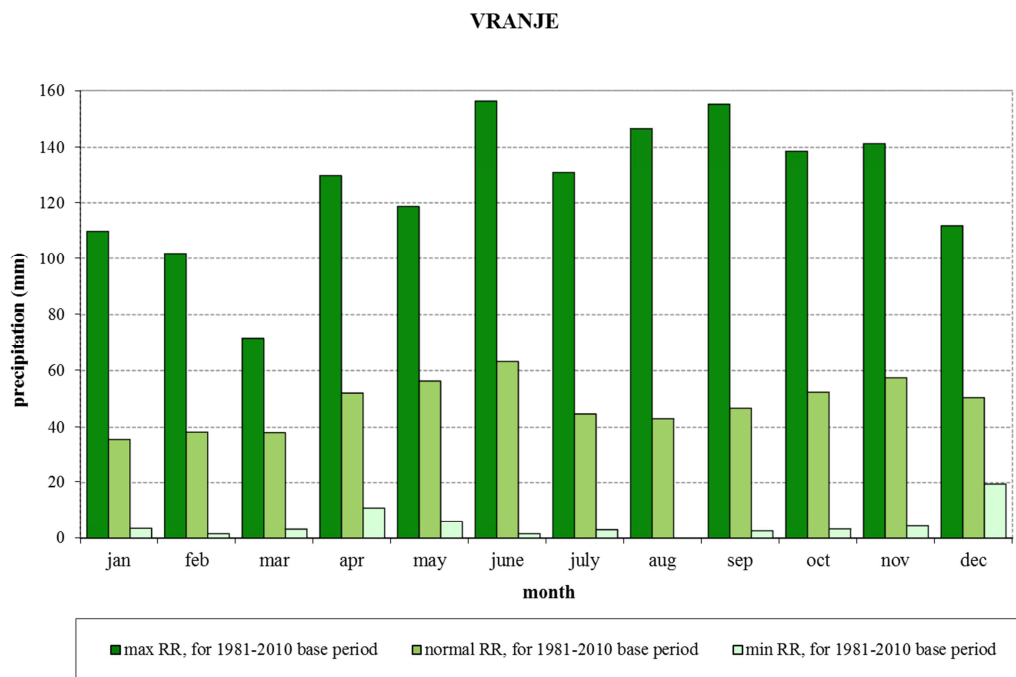
Major part of Serbia has continental precipitation regime with higher quantities in the warmer part of the year. The highest monthly precipitation quantities were observed in Belgrade and Loznica during July (above 250 mm, on Zlatibor mountain above 200 mm), in Negotin during November (above 200 mm) and in Vranje during June (above 150 mm).

The highest daily precipitation quantity of 189,7 mm in the period between 1981-2010 was recorded in Vrsac on July 18 1995.

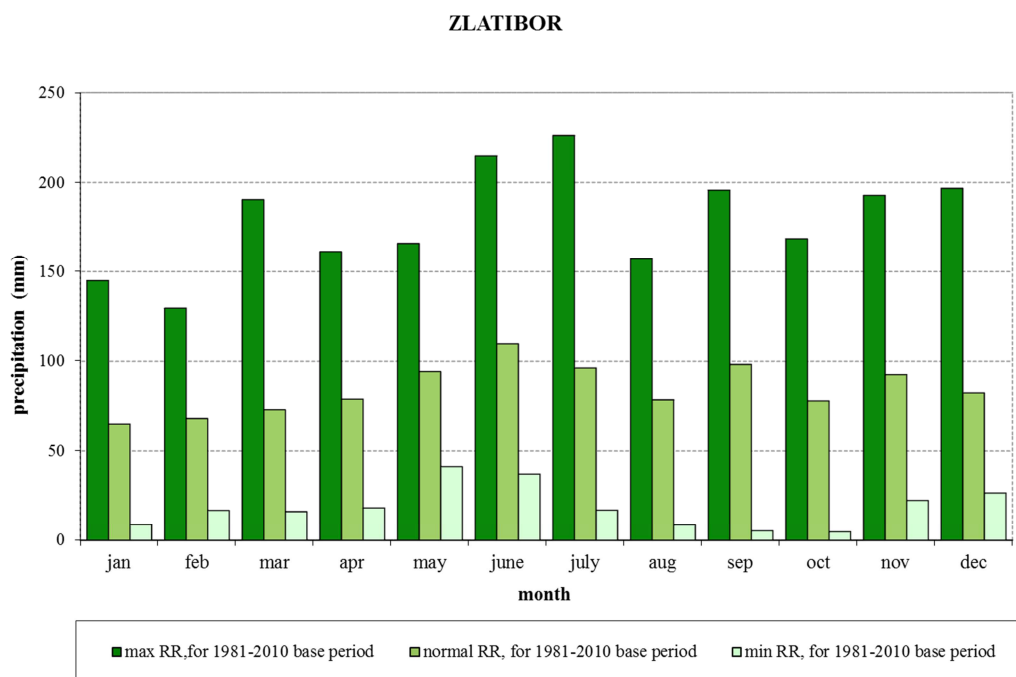
Monthly mean, maximum and minimum precipitation sums for the 1981-2010 base period are shown in Figures 6 -10.



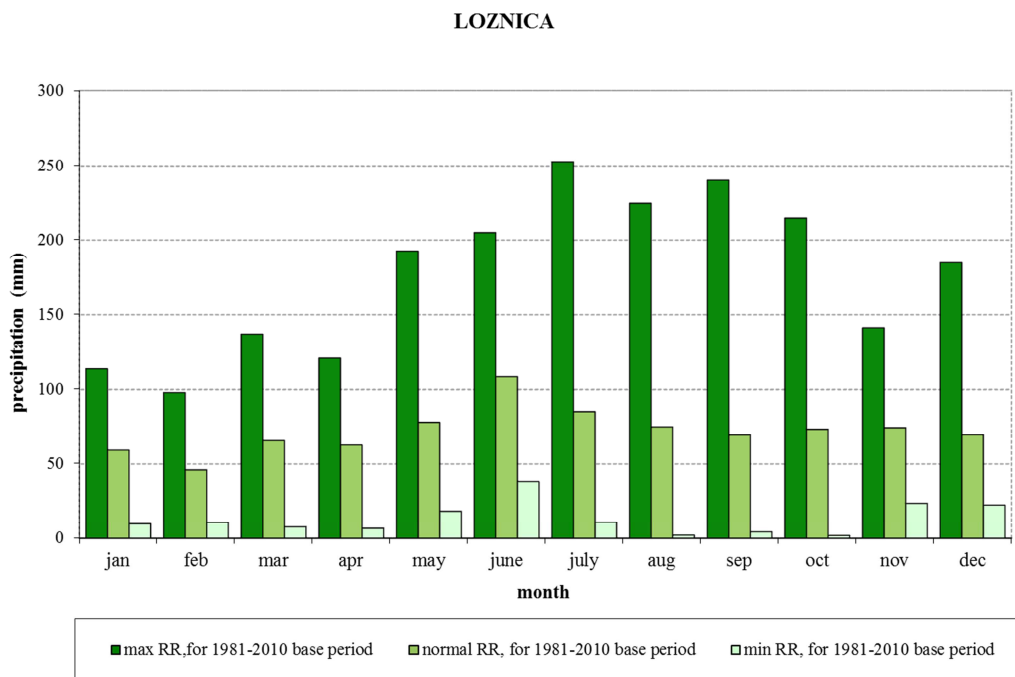
Graph 6. Monthly mean, maximum and minimum precipitation sums for the 1981-2010 base period for Belgrade



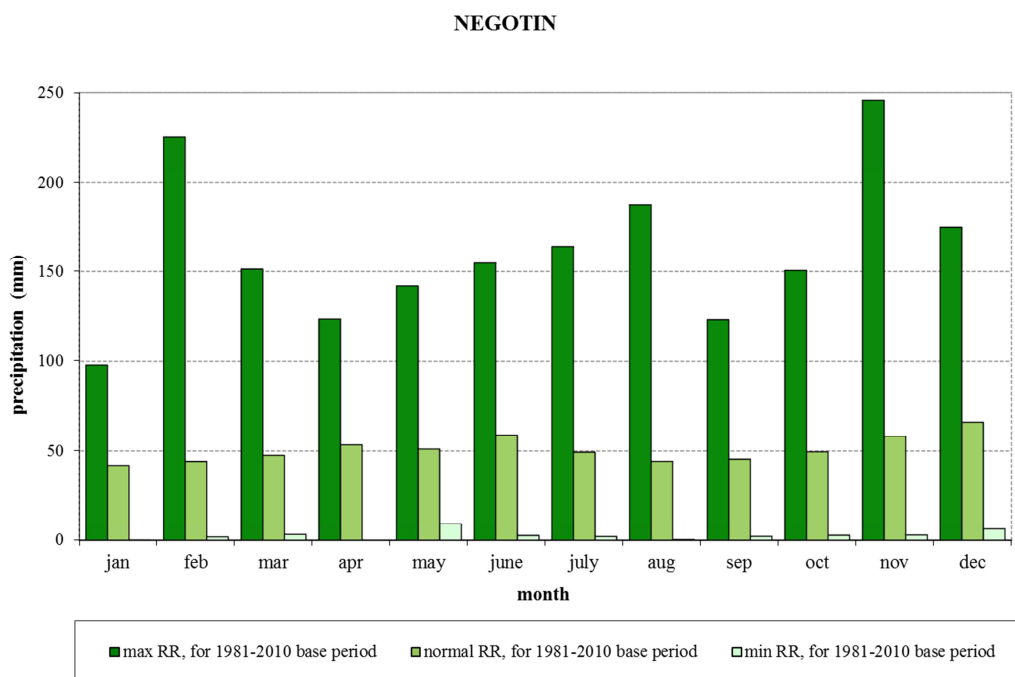
Graph 7. Monthly mean, maximum and minimum precipitation sums for the 1981-2010 base period for Vranje



Graph 8. Monthly mean, maximum and minimum precipitation sums for the 1981-2010 base period for Zlatibor Mountain



Graph 9. Monthly mean, maximum and minimum precipitation sums for the 1981-2010 base period for Loznica



Graph 10. Monthly mean, maximum and minimum precipitation sums for the 1981-2010 base period for Negotin

Annual number of days with precipitation sums above 0,1 mm in Serbia ranges between 117 in Negotin up to 171 on Zlatibor Mountain (Figure 7). The highest number of days is recorded in the period between April and June, while the least number is characteristic for August (only 7 days in Negotin).

The average number of days with precipitation above 10 mm is 20 days (31 on Kopaonik Mountain), in Vojvodina between 16-20 days (Figure 8).

The average number of days with snow cover in Serbia ranges between 29 and 49 days while on the mountains it is more than 100 days: Kopaonik 162, Crni Vrh 123 and Zlatibor 111 (Figure 9). The maximum snow depth was recorded on the following mountains: on Kopaonik between February 15-17 1984, measuring 198cm, on Crni Vrh on January 25 2000, measuring 167 cm, and on Zlatibor on February 12 1984, measuring 92 cm.

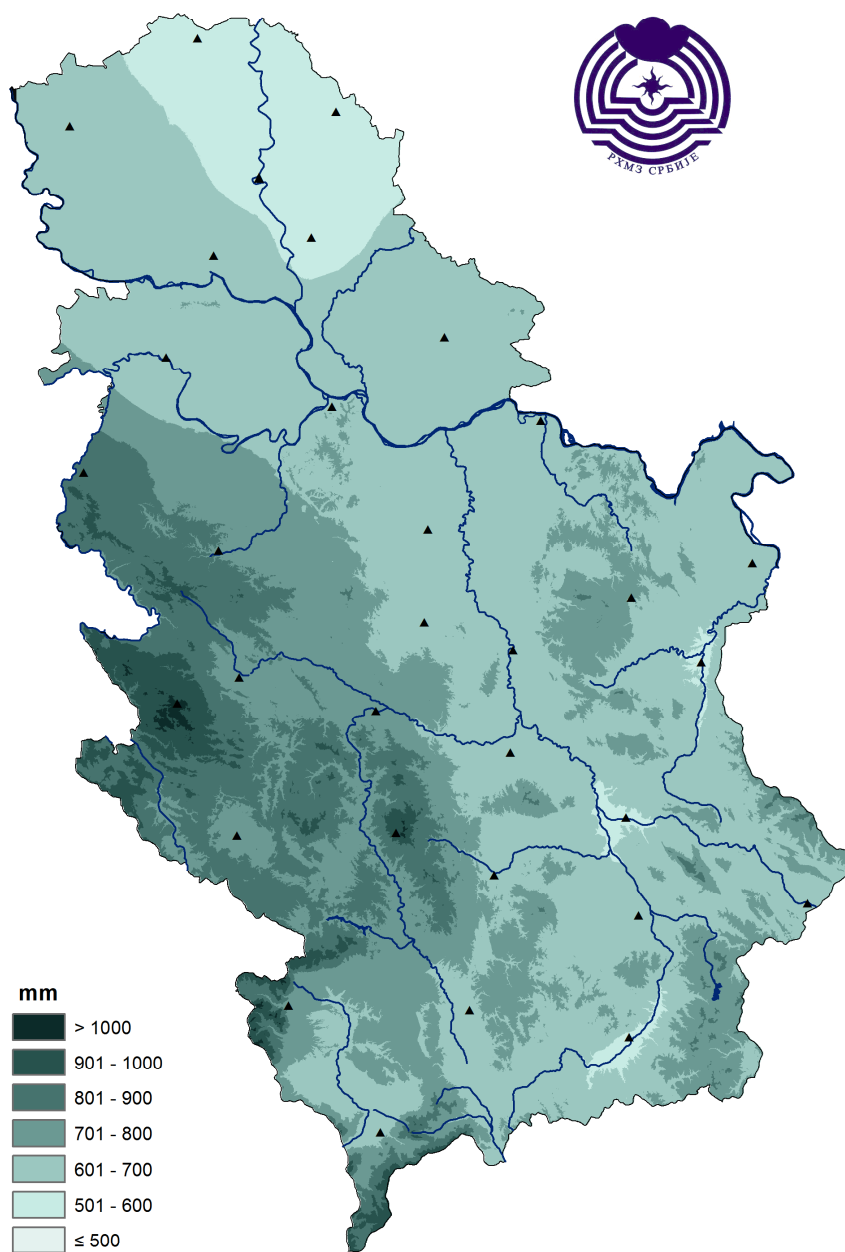


Figure 6. Average precipitation totals for the 1981-2010 base period

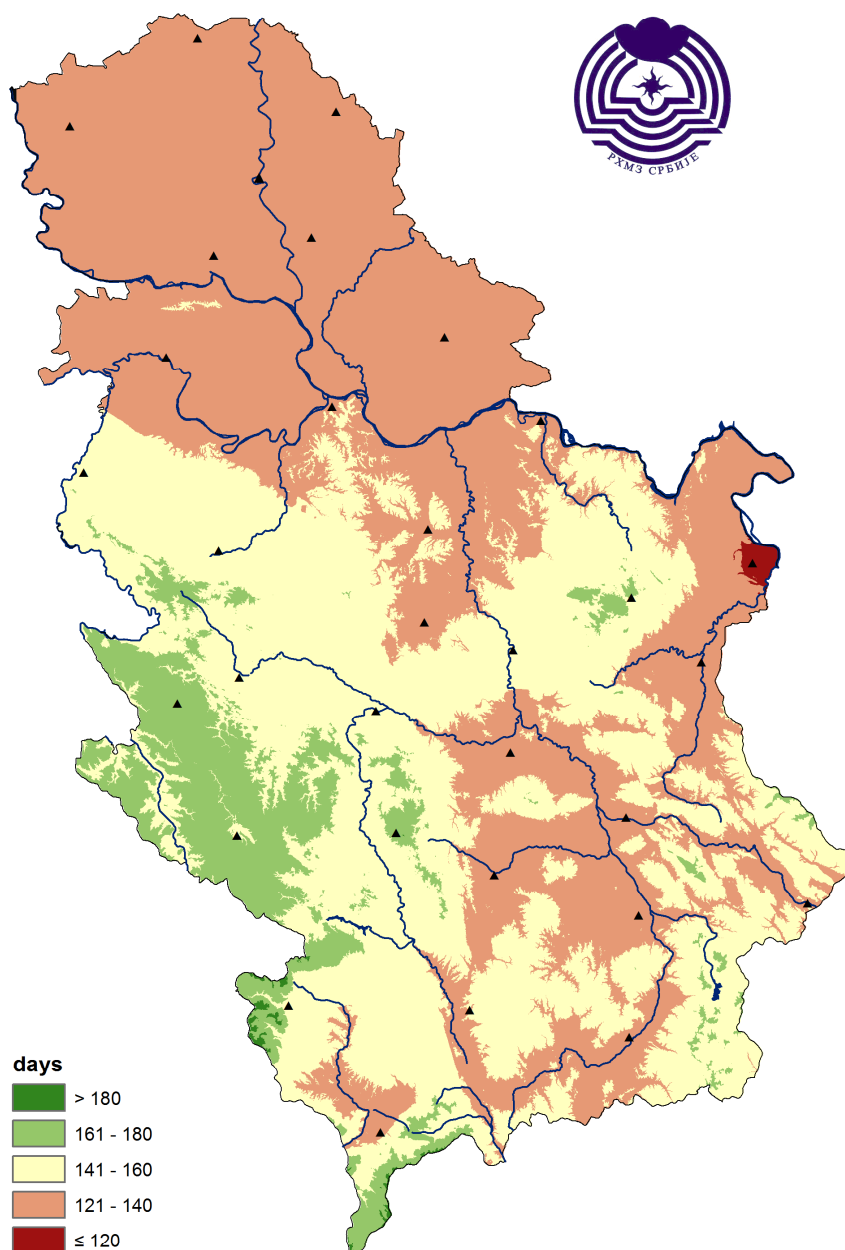


Figure 7. Average number of days with precipitation sums above 0,1 mm for the 1981-2010 base period

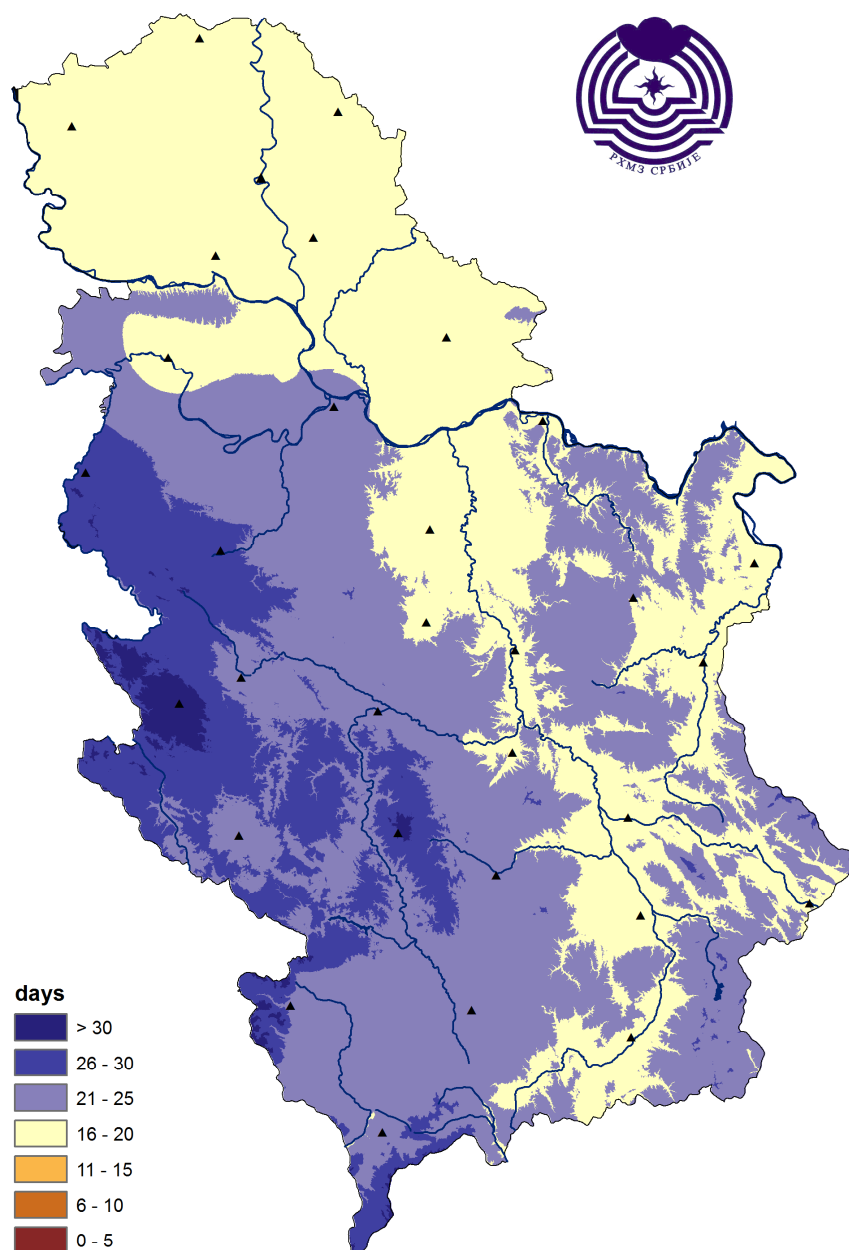


Figure 8. Average number of days with precipitation sums above 10 mm for the 1981-2010 base period

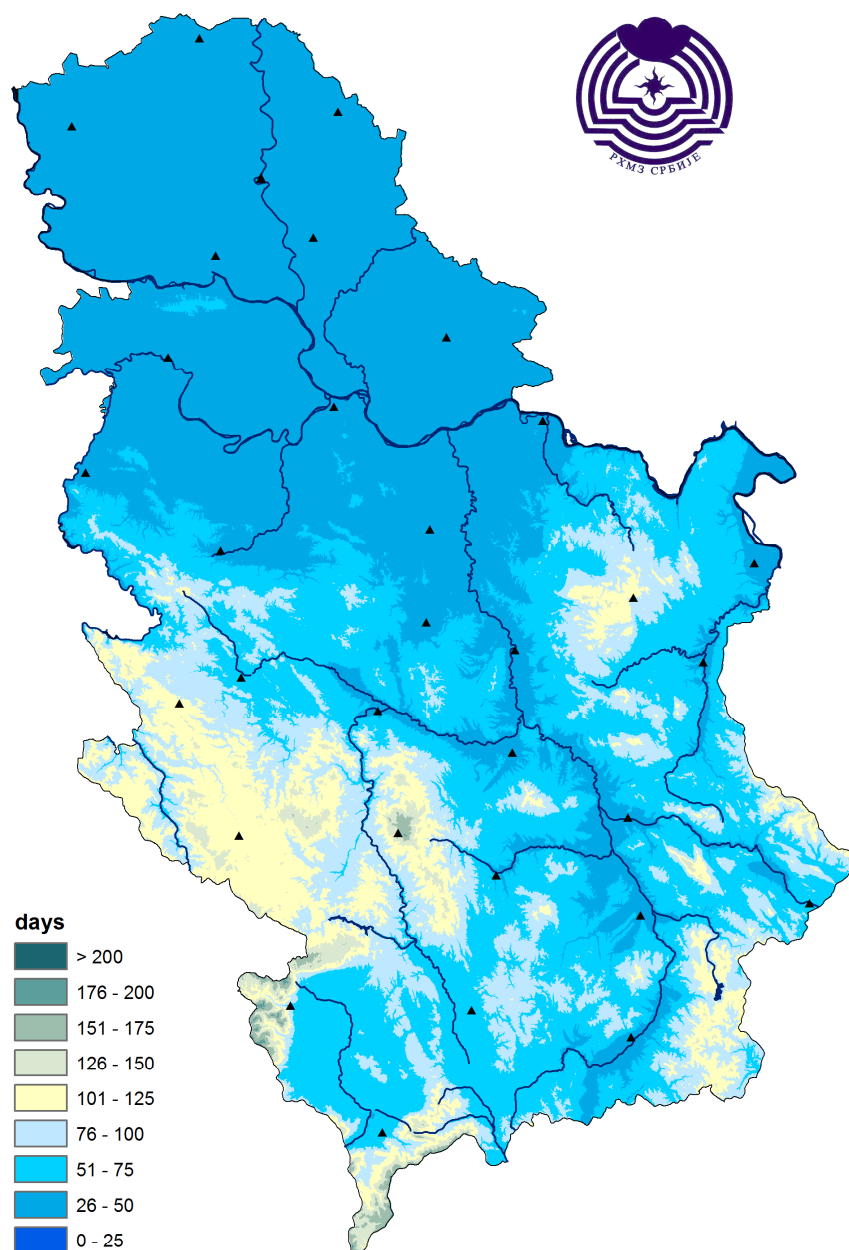


Figure 9. Average number of days with snow cover for the 1981-2010 base period

Other climate characteristics

Average sunshine duration in Serbia is in a range between 1508 hours in Pozega up to 2188 hours in Palic annually (Figure 10). The insolation averages around 800 hours during summer and 200 hours during winter.

The average number of bright days⁶ in Serbia ranges between 34 in Pozega up to 88 in Negotin (Figure 11). The highest number of bright days is observed during August (ranging from 14 in Negotin, Leskovac and Kursumlija, elsewhere between 7 and 13).

The average number of cloudy days⁷ is in a range between 93 in Vrsac up to 129 in Pozega. The number of cloudy days registered during summer is 10 days, while during winter it is 40 days (Figure 12).

An average relative humidity⁸ for the 1981-2010 base period in Serbia is 80%. The highest relative humidity of 80% is registered during winter and the lowest one of 65% is observed during summer (Chart 1).

Surface air circulation is to a great extent caused by orography. In warmer part of the year winds from northwest and west prevail. During colder part of the year, east and southeast wind – Kosava dominates. Winds from southwestern direction prevail in mountainous parts of southwestern Serbia (Figure 13).

⁶ Bright day is defined a day with cloudiness below 2/8

⁷ Cloudy day is defined as a day with cloudiness above 6/8

⁸ Relative humidity is defined as the water vapor density to the saturation of the water vapor density

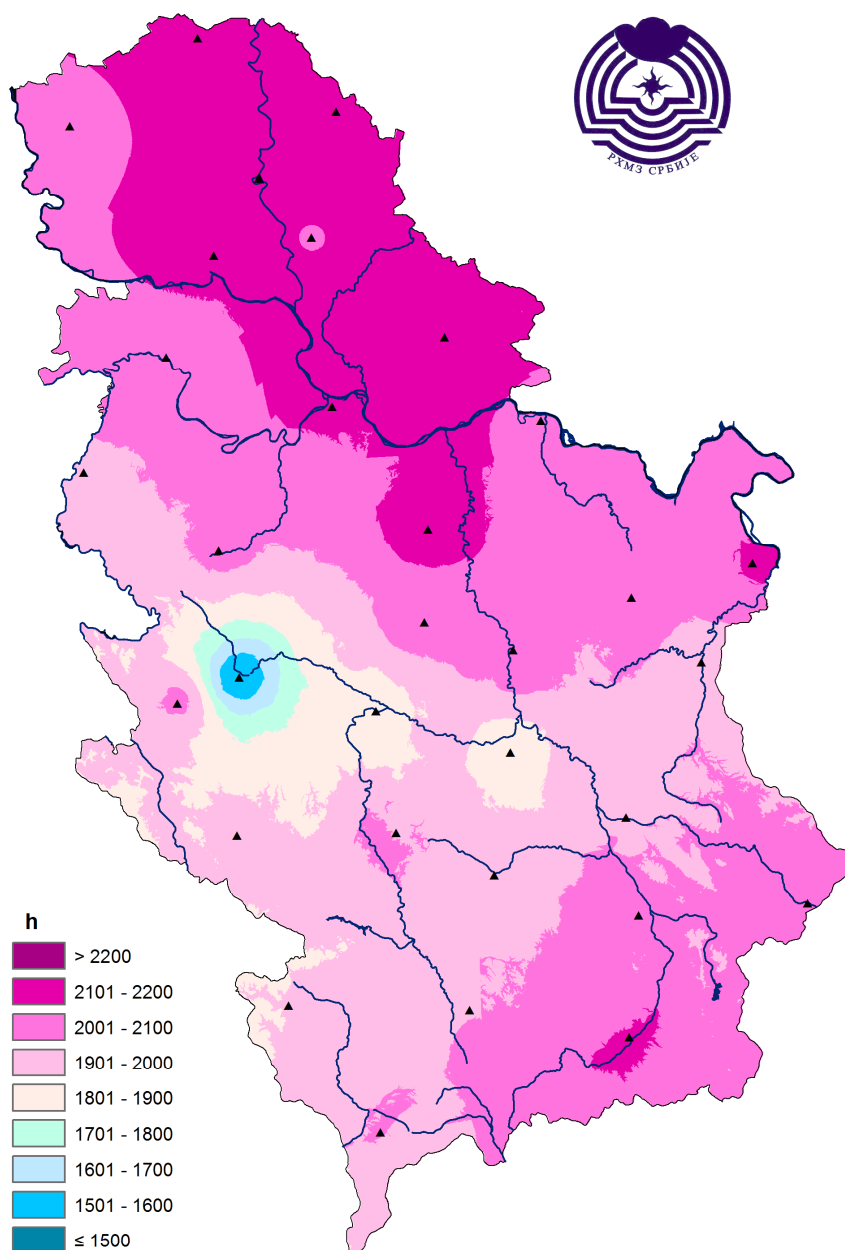


Figure 10. An average insolation during 1981-2010 base period

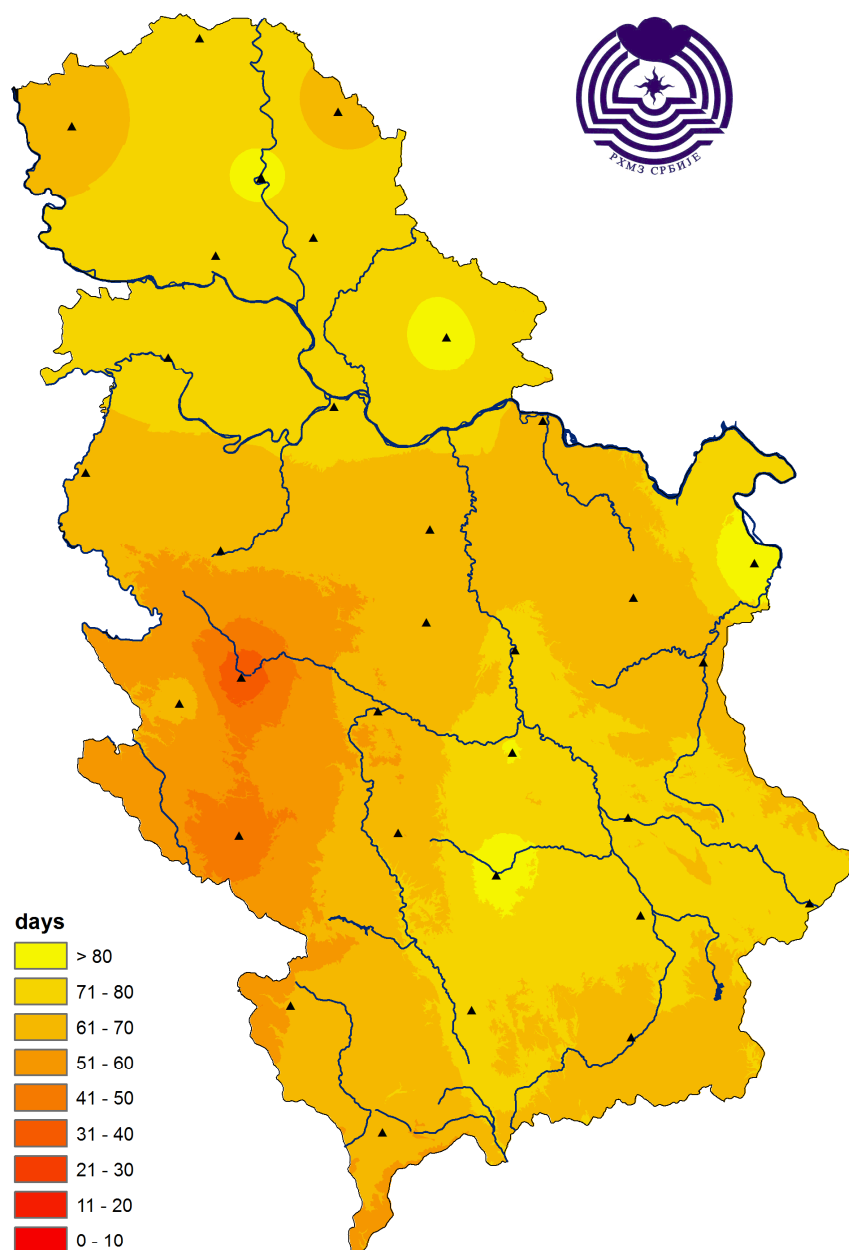


Figure 11. An average number of the bright days for the 1981-2010 base period

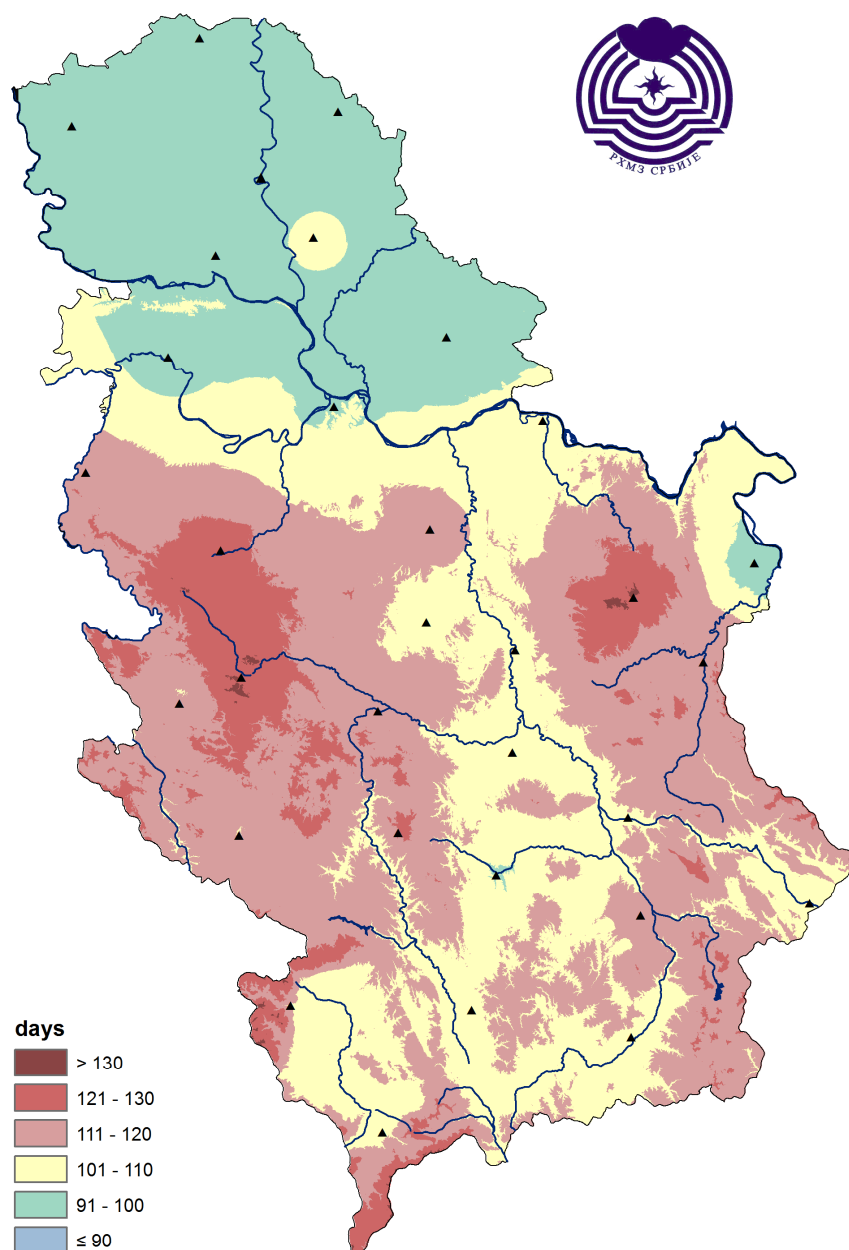


Figure 12. An average number of the cloudy days for the 1981-2010 base period

Chart 1.

AVERAGE RELATIVE HUMIDITY (%) for 1981-2010 base period													
station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	год.
Palic	85,2	79,1	71,2	65,7	63,9	63,9	62,2	64,3	70,2	74,5	82,2	86,7	72,4
Sombor	83,7	77,6	70,5	66,4	63,8	64,9	63,9	65,7	71,2	74,7	81,8	85,5	72,5
Kikinda	86,2	79,8	70,9	65,7	64,2	66,5	64,0	65,3	70,5	74,7	82,2	87,2	73,1
Becej	85,6	78,6	69,5	65,3	62,1	64,7	62,6	64,2	68,9	72,8	81,0	85,9	71,8
Zrenjanin	84,7	78,4	70,1	66,2	64,7	67,6	65,9	65,6	70,7	74,3	81,1	85,9	72,9
Novi Sad	85,1	79,2	70,9	67,0	66,4	69,2	67,5	67,6	72,3	75,6	82,1	85,7	74,0
S. Mitrovica	87,4	80,6	72,8	69,4	68,1	71,6	71,0	70,7	75,1	77,9	84,5	88,3	76,4
Zlatibor	83,0	79,5	74,3	69,9	70,0	72,7	70,4	70,2	75,2	77,6	80,4	84,7	75,7
B. Karlovac	84,4	79,1	71,0	68,1	67,1	69,6	68,3	68,0	72,1	75,0	80,8	85,0	74,0
Beograd	77,9	71,2	63,3	60,8	60,9	63,3	61,0	61,4	67,3	71,2	75,4	79,0	67,7
Loznica	83,1	77,8	71,5	68,8	69,0	70,7	69,3	70,6	75,9	80,0	82,0	83,9	75,2
Valjevo	81,6	76,4	70,1	68,2	68,1	69,6	67,2	68,5	74,1	78,1	80,5	82,4	73,7
V. Gradiste	82,5	77,1	69,4	67,0	67,8	70,0	67,6	66,9	71,6	74,1	78,1	83,1	72,9
S.Palanka	81,0	75,2	68,1	66,1	66,7	68,5	65,7	66,4	71,5	75,3	78,4	82,1	72,1
Kragujevac	79,3	74,7	68,6	66,8	68,2	68,5	65,4	66,5	71,6	74,8	77,1	80,4	71,8
Kraljevo	81,4	75,0	69,0	66,4	68,8	70,0	67,5	67,8	73,4	77,2	79,3	82,4	73,2
Pozega	85,7	79,7	73,7	71,1	73,1	74,6	73,9	75,1	78,9	81,9	84,5	86,8	78,2
Cuprija	81,8	76,6	70,6	68,3	68,8	70,1	67,5	67,2	73,0	76,8	79,3	82,7	73,6
Krusevac	84,7	79,1	72,9	70,8	72,3	72,2	69,9	69,4	74,2	78,5	81,4	85,3	75,9
Negotin	79,7	75,0	69,5	66,4	65,6	63,3	59,9	61,8	68,6	76,5	80,5	82,5	70,8
Zajecar	79,0	75,0	70,6	68,7	69,0	67,8	64,3	65,9	71,4	77,8	80,6	81,9	72,7
Kopaonik	81,1	82,7	81,7	80,2	78,7	78,6	75,1	74,2	80,1	79,7	81,6	83,5	79,8
Sjenica	82,5	80,1	76,7	72,4	72,1	73,2	72,2	73,1	77,5	78,8	81,1	83,7	77,0
Crni Vrh	85,0	83,4	79,1	74,5	73,5	75,1	71,4	70,2	76,2	81,9	84,9	86,3	78,5
Nis	79,9	73,9	66,1	63,5	64,8	65,0	61,2	61,3	68,5	73,2	77,4	80,6	69,6
Vranje	81,5	74,8	67,2	63,9	65,2	64,4	60,5	60,4	66,9	73,3	79,5	83,2	70,1
Dimitrovgrad	81,4	77,0	69,9	67,1	69,2	70,1	66,4	66,3	71,2	75,1	78,9	82,4	72,9
Leskovac	82,0	76,7	70,2	68,2	69,1	68,2	65,0	66,1	73,3	77,4	80,4	82,9	73,3
Kursumlija	83,1	79,5	73,9	71,8	74,3	75,2	72,3	72,6	77,6	80,9	82,4	84,0	77,3
Vrsac	80,9	75,6	68,2	65,0	65,2	68,0	65,4	64,1	68,2	70,4	75,2	81,1	70,6

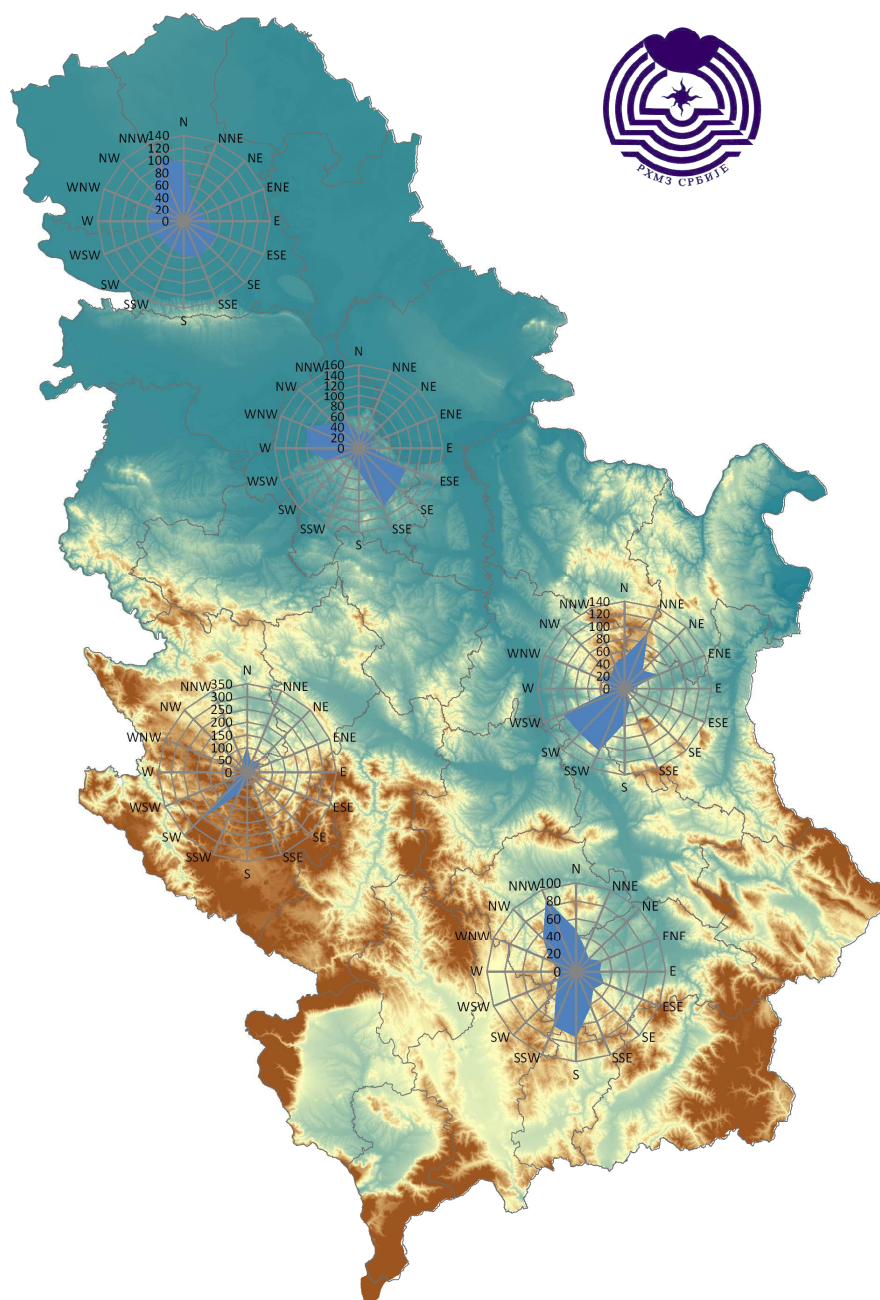


Figure 13. Representation of the wind rose for the 1981-2010 base period