**Republic Hydrometeorological Service of Serbia**
Kneza Viseslava 66
11000 Belgrade
Republic of Serbia

# SEASONAL BULETIN FOR SERBIA

# Autumn 2023

Belgrade, December 8th 2023

Division for Climate Monitoring and Climate Forecast
Department of National Center for Climate Change, Climate Model Development and Disaster Risk Assessment
web: http://www.hidmet.gov.rs
mail: office@hidmet.gov.rs

# Contents

Analysis of the autumn 2023 for Serbia relative to the 1991-2020 base period ..... 2
Temperature ..... 2
Heat and cold waves ..... 11
Precipitation ..... 12
Sunshine duration (insolation) ..... 17
Analysis of the autumn 2023 for Serbia relative to the 1961-1990 base period ..... 18
Temperature ..... 18
Precipitation ..... 19

- ***The warmest autumn for Serbia since 1951***
- ***Record-breaking number of summer days at 17 MMS***
- ***Record-breaking number of tropical days for Novi Sad (12 days) and Sombor (11 days)***
- ***Exceeded autumn daily precipitation maximum for Zrenjanin***
- ***Record snow depth for Vranje***

# Analysis of the autumn 2023 for Serbia relative to the 1991-2020 base period

## Temperature

Autumn 2023 ranks as **the warmest** in the period from 1951 to 2023 (*Figure 1).* This autumn is warmest at most main meteorological stations since the record-keeping began (*Chart 1*).

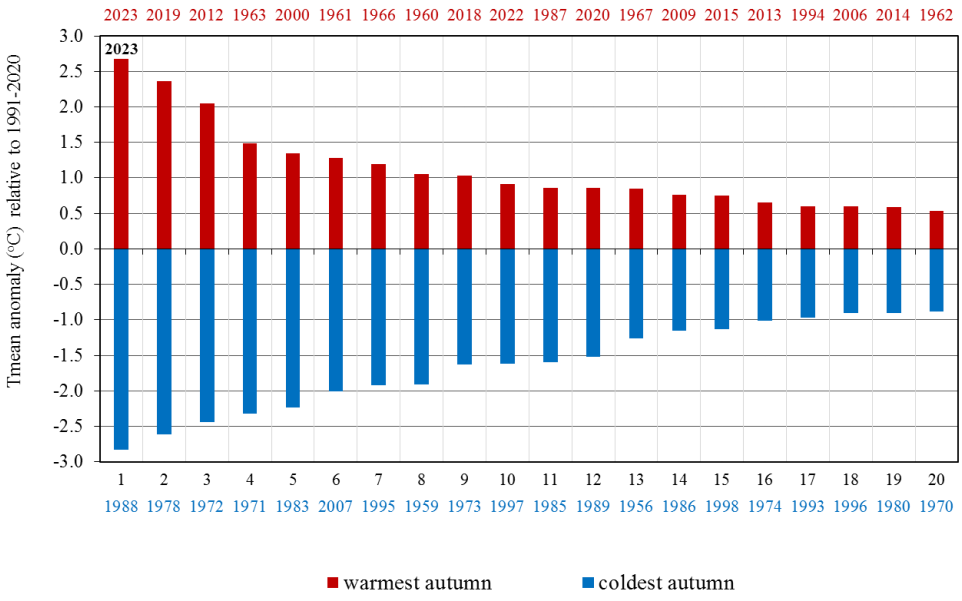



Figure 1. Rank of the warmest and coldest autumn seasons for Serbia for the 1951-2023 period

Chart 1. Ranking of autumn 2023 with mean air temperature, average and departure from the normal 1991-2020

| STATION | historical period | Tmean (°C) - Autmn 2023 | 1991-2020 base period for Autmn | temperature anomaly (oC) | ranking for Autmn 2023 |
|---|---|---|---|---|---|
| **LOZNICA** | 1952-2022 | 15.6 | 12.2 | 3.4 | 1 |
| **NOVI SAD** | 1948-2022 | 15.4 | 12.0 | 3.4 | 1 |
| **CRNI VRH** | 1966-2022 | 10.8 | 7.6 | 3.2 | 1 |
| **BELGRADE** | 1887-2022 | 16.4 | 13.3 | 3.1 | 1 |
| **VALJEVO** | 1926-2022 | 15.0 | 12.1 | 3.0 | 1 |
| **CUPRIJA** | 1948-2022 | 14.8 | 11.8 | 3.0 | 1 |
| **ZRENJANIN** | 1943-2022 | 15.2 | 12.2 | 2.9 | 1 |
| **PALIC** | 1945-2022 | 14.5 | 11.7 | 2.9 | 1 |
| **SOMBOR** | 1941-2022 | 14.4 | 11.5 | 2.9 | 1 |
| **KRALJEVO** | 1926-2022 | 14.9 | 12.1 | 2.8 | 1 |
| **S.MITROVICA** | 1925-2022 | 14.7 | 11.9 | 2.8 | 1 |
| **KURSUMLIJA** | 1952-2022 | 13.8 | 11.0 | 2.8 | 1 |
| **NIS** | 1925-2022 | 15.4 | 12.7 | 2.7 | 1 |
| **KRAGUJEVAC** | 1925-2022 | 14.9 | 12.3 | 2.7 | 1 |
| **KIKINDA** | 1948-2022 | 14.7 | 11.9 | 2.7 | 1 |
| **LESKOVAC** | 1948-2022 | 14.3 | 11.6 | 2.7 | 1 |
| **NEGOTIN** | 1927-2022 | 14.7 | 12.2 | 2.6 | 1 |
| **B.KARLOVAC** | 1986-2022 | 14.6 | 12.1 | 2.6 | 1 |
| **S.PALANKA** | 1939-2022 | 14.6 | 12.1 | 2.5 | 1 |
| **POZEGA** | 1952-2022 | 12.5 | 10.2 | 2.3 | 1 |
| **ZAJECAR** | 1929-2022 | 13.3 | 11.1 | 2.2 | 1 |
| **KRUSEVAC** | 1930-2022 | 14.6 | 12.0 | 2.6 | 2 |
| **ZLATIBOR** | 1950-2022 | 11.6 | 8.9 | 2.6 | 2 |
| **DIMITROVGRAD** | 1945-2022 | 13.4 | 10.9 | 2.5 | 2 |
| **V.GRADISTE** | 1926-2022 | 14.1 | 12.0 | 2.1 | 2 |
| **SJENICA** | 1946-2022 | 9.9 | 7.8 | 2.1 | 2 |
| **VRANJE** | 1926-2022 | 14.6 | 12.0 | 2.6 | 3 |
| **KOPAONIK** | 1950-2022 | 7.1 | 5.1 | 2.0 | 3 |

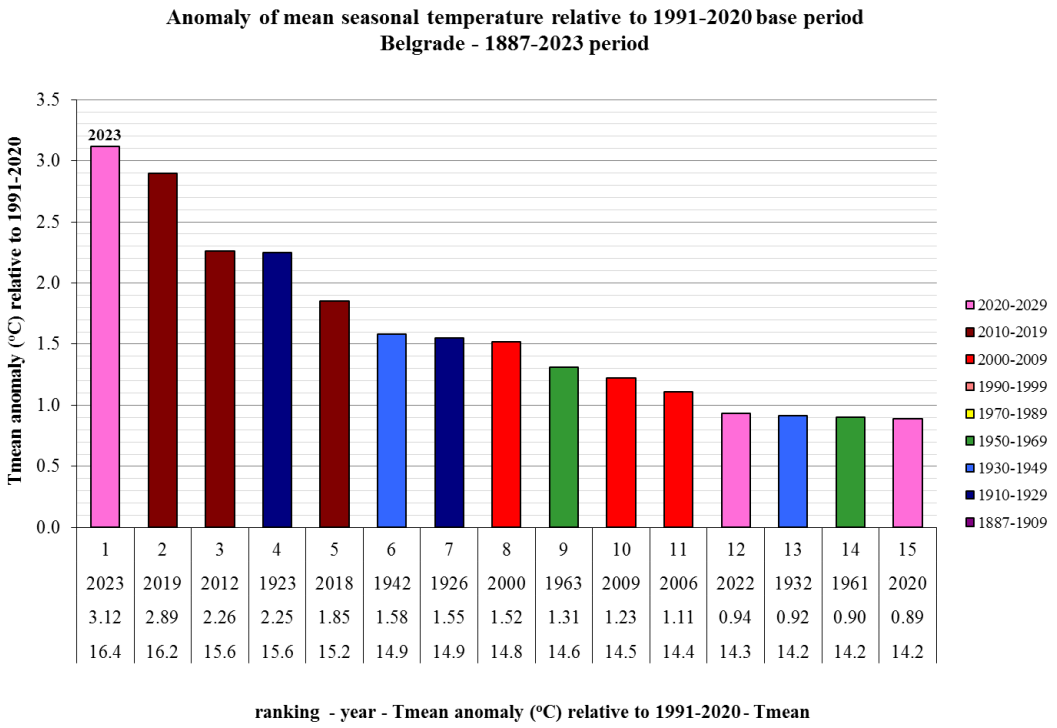



Figure 2. Rank of the warmest autumn seasons in Belgrade for the 1887-2023 period

Mean autumn air temperature ranged from 12,5ºC in Pozega to 16,4ºC in Belgrade, and on the mountains from 7,1ºC at Kopaonik to 11,6ºC at Zlatibor (*Figure 3*).

During autumn, departure of the mean air temperature from the normal [1], ranged from +2,0ºC at Kopaonik to +3,4ºC in Loznica and Novi Sad. Seasonal departure in Belgrade was +3,1ºC (*Figure 4*).

Based on the percentile method [2], mean autumn air temperature was in the categories of extremely warm in most of Serbia and very warm in Veliko Gradiste, Zlatibor and Kopaonik (*Figure 5).*

Based on the tercile method, mean autumn air temperature was in the warm category in most of the country (*Figure 6).*

[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, 1991 to December 31, 2020

[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

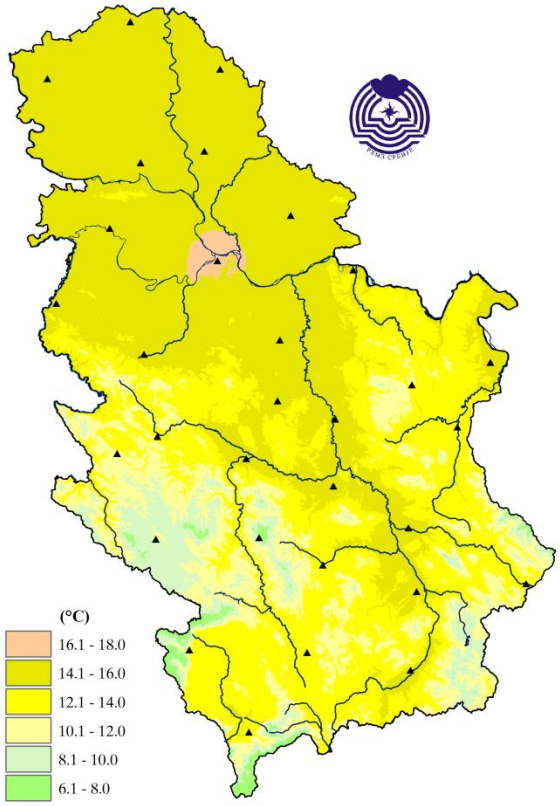



Figure 3. Spatial distribution of mean sasonal air temperature

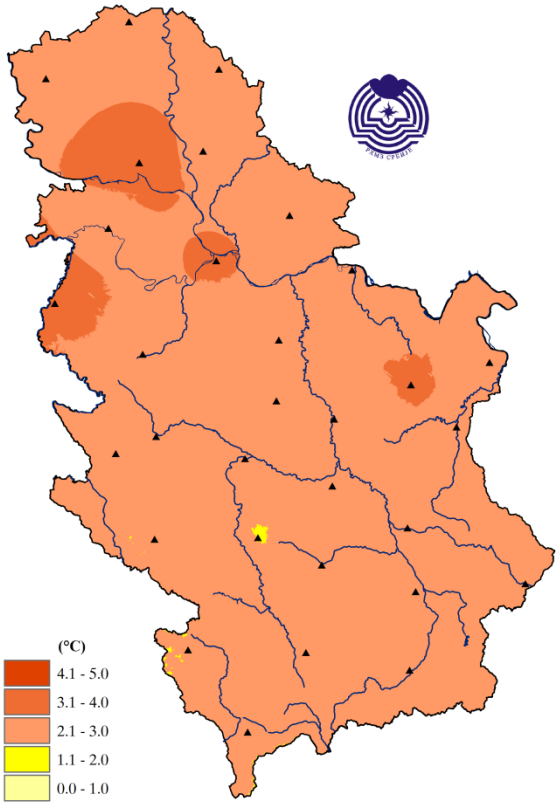



Figure 4. Mean seasonal air temperature anomaly from normal

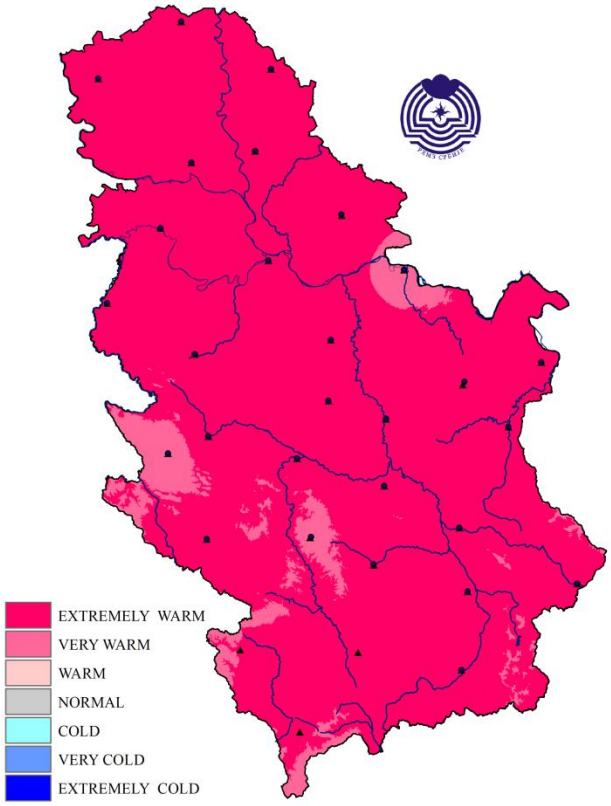



Figure 5. Spatial distribution of mean seasonal air temperature according to the percentile method

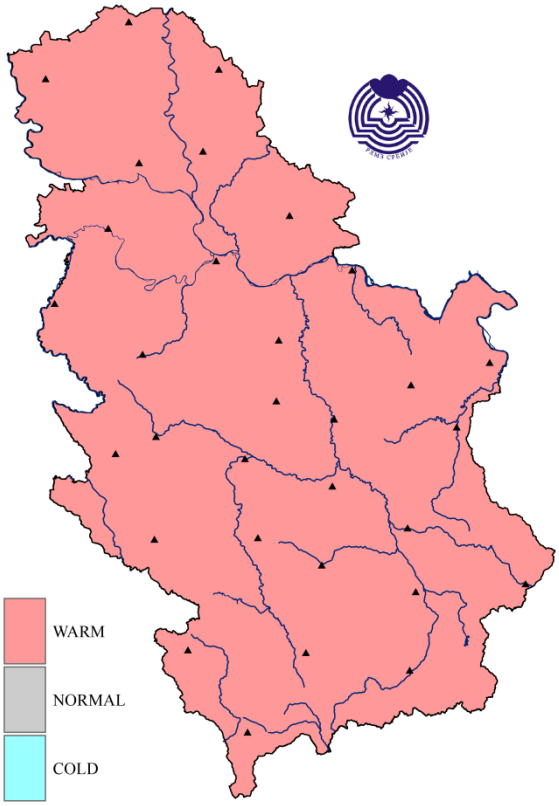



Figure 6. Spatial distribution of mean seasonal air temperature according to the tercile method

During autumn, the highest daily air temperature of 36,4ºC was measured in Cuprija on September 23.

Number of summer days[3] at 17 MMS was **the highest ever recorded** during autumn, while in Dimitrovgrad the previous maximum is equaled (Chart 2). The recorded number of summer days ranged from 29 in Pozega to 47 in Loznica, reaching up to 11 days in the upland as in Sjenica. The number of summer days was 14 to 27 days above the autumn average in most of Serbia (*Figure 7).*

Chart 2. The exceeded number of summer days

| MMS station | Number of summer days autumn 2023 | Summer days average | Deviation of the number of summer days | Exceeded maximum of the number of summer days | Year of the maximum |
|---|---|---|---|---|---|
| **LOZNICA** | **47** | 18.5 | **28.5** | 34 | 2011/2019 |
| **NIS** | **46** | 21.7 | **24.3** | 39 | 1932/2019 |
| **VALjEVO** | **45** | 19.2 | **25.8** | 38 | 1935 |
| **CUPRIJA** | **45** | 18.5 | **26.5** | 39 | 2019 |
| **KRAGUJEVAC** | **42** | 18.0 | **24.0** | 38 | 2019 |
| **LESKOVAC** | **42** | 20.0 | **22.0** | 40 | 2019 |
| **S.PALANKA** | **41** | 17.5 | **23.5** | 39 | 2019 |
| **NOVI SAD** | **40** | 16.3 | **23.7** | 33 | 2011 |
| **BELGRADE** | **40** | 17.5 | **22.5** | 36 | 2019 |
| **KRUSEVAC** | **40** | 19.4 | **20.6** | 39 | 2019 |
| **ZAJECAR** | **40** | 18.7 | **21.3** | 38 | 2019 |
| **ZRENjANIN** | **39** | 16.6 | **22.4** | 34 | 2011 |
| **B.KARLOVAC** | **39** | 17.7 | **21.3** | 37 | 2019 |
| **DIMITROVGRAD** | **39** | 16.1 | **22.9** | izj. | 2019 |
| **S.MITROVICA** | **38** | 18.0 | **20.0** | 37 | 1939 |
| **SOMBOR** | **36** | 15.6 | **20.4** | 32 | 1942 |
| **KIKINDA** | **36** | 15.3 | **20.7** | 32 | 2019 |
| **PALIC** | **33** | 13.6 | **19.4** | 28 | 2011 |

Tropical days[4] were recorded only in the lowland. The lowest number of tropical days ranged from 4 in Veliko Gradiste, Pozega and Kursumlija to 16 in Leskovac. Belgrade observed 12 tropical days. In most of Serbia, number of tropical days was 3 to 10 days above the average (*Figure 8).* **Novi Sad and Sombor observed record-breaking number of tropical days** during autumn. Novi Sad saw 14 days thereby besting the previous record of 12 days set in autumn 1987 and 2011. Sombor experienced 13 tropical days breaking the previous record of 11 days set in autumn 2011.

Number of ice days[5] was the following: 6 days-Kopaoniku, 4 days - Crni Vrh, 1 day – Sjenica and Zlatibor.

During autumn, the lowest daily air temperature of -12,9ºC was measured in Sjenica on November 27. As for the lowland, the lowest air temperature of -5,9ºC was measured in Vranje on November 27. On the same day, Belgrade observed the lowest air temperature of -0,5ºC.

[3] Summer day refers to a day with maximum air temperature 25°C and above
[4] Tropical day refers to a day with maximum air temperature 30°C and above
[5] Ice day is defined as the day with maximum air temperature lower than 0°C

Number of tropical nights[6] was the following: 3 - Belgrade, 1 – Kikinda, Loznica, Valjevo, Ćuprij and Vranje.

Frost days[7] were recorded across the entire country, ranging from 2 in Kragujevac, Negotin, Krusevac and Nis to 9 in Sombor. In the upland, number of frost days ranged from 11 days at Crni Vrh to 19 days in Sjenica. The observed number of frost days was 2 to 9 days below the average in most of Serbia (*Figure 9).*

Days with severe frost[8] were recorded at Kopaonik (2 days) and Sjenica (1 day).

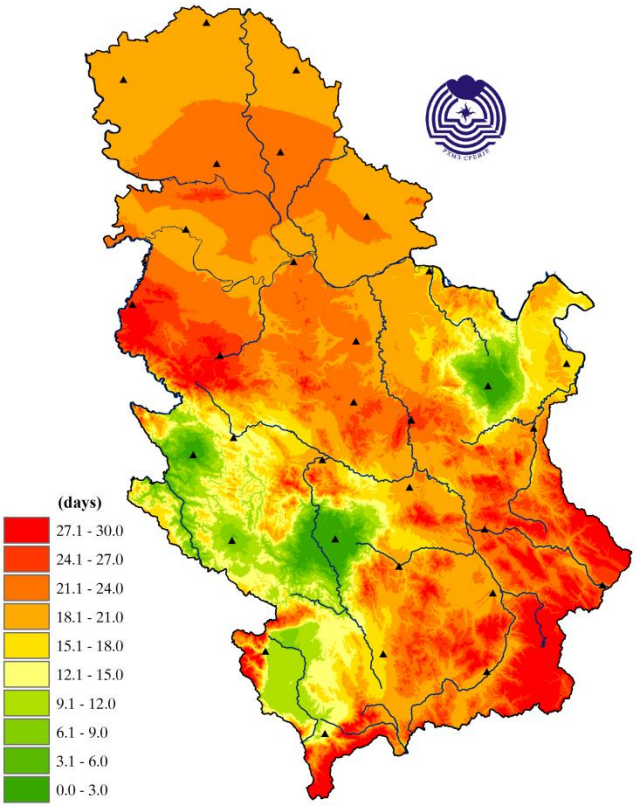



Figure 7. Deviation of the number of summer days from the normal

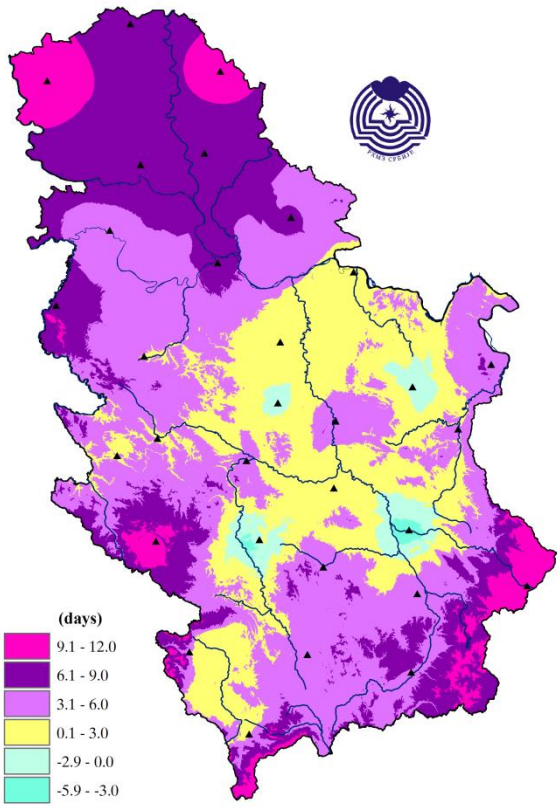



Figure 8. Deviation of the number of tropical days from the normal

[6] Tropical night is defined as the day with the minimum daily air temperature of 20°C and above
[7] Frost day is defined as the day with minimum air temperature lower than 0°C
[8] Day with severe frost is defined as the day with the minimum air temperature below -10°C

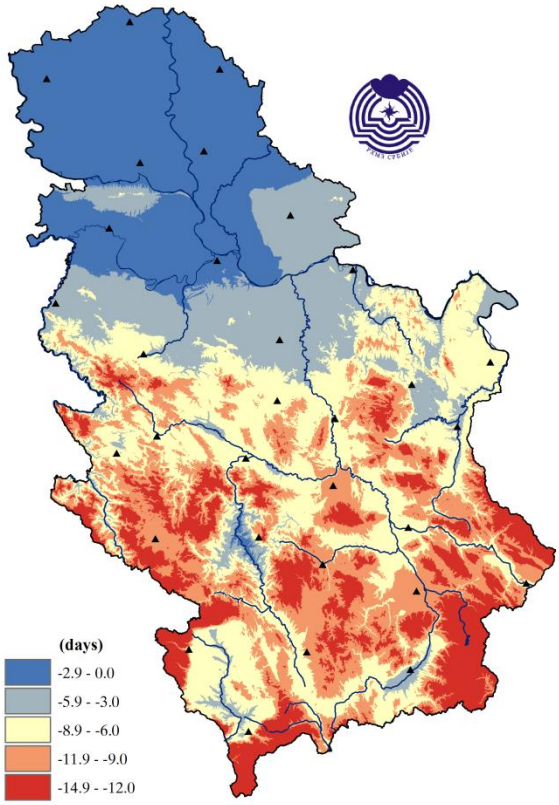



Figure 9. Deviation of the number of frost days from the normal

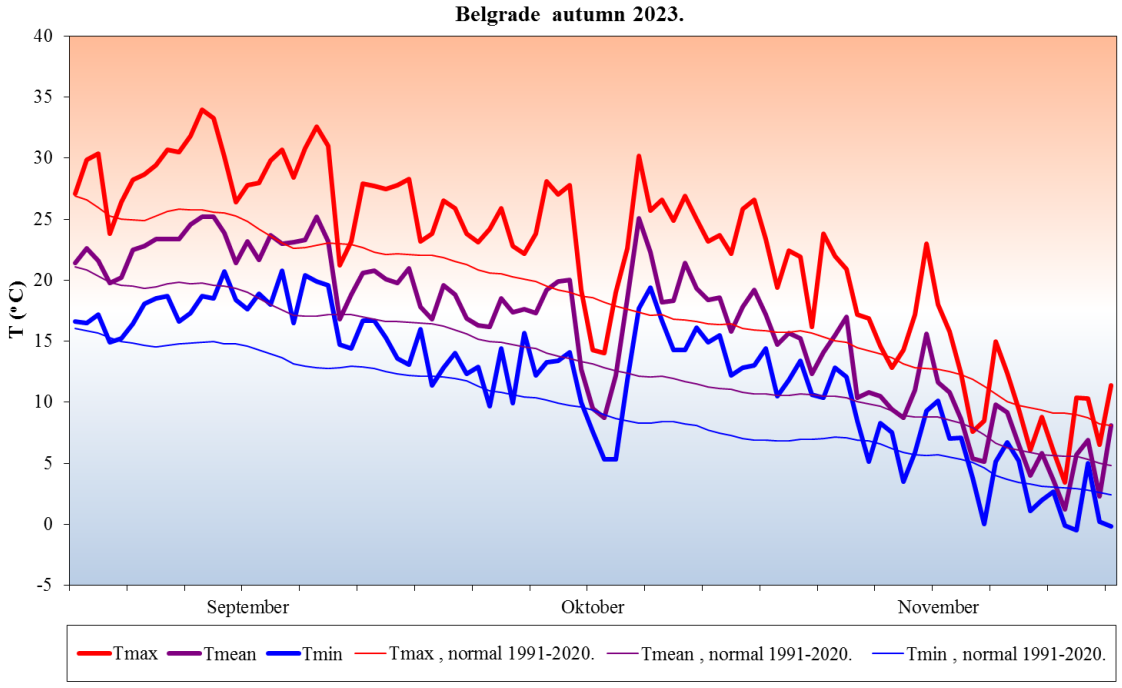



Figure 10. Three – month course of mean, maximum and minimum air temperature in Belgrade

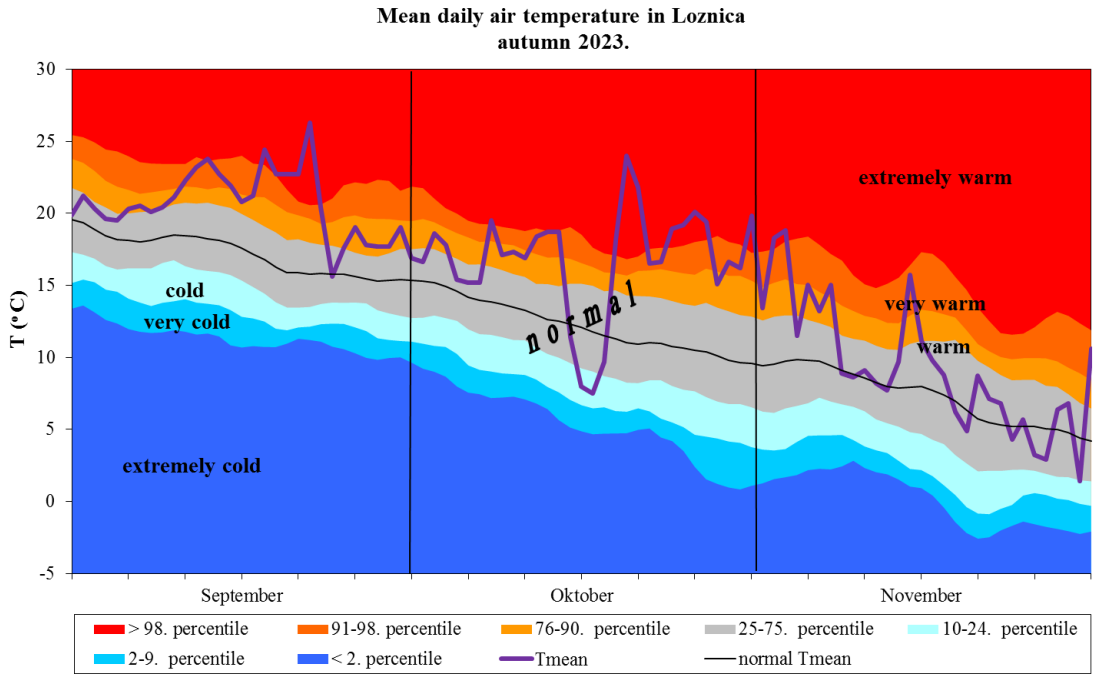



Figure 11. Three – month course of mean daily air temperature in Loznica

Assessment of the mean air temperature and precipitation sums (*Figure 12*) for Serbia based on the tercile distribution compared to the 1991-2020 base period shows that the autumn 2023 was marked by air temperatures significantly below the upper tercile threshold and that they were **the highest** in a period from 1951, whereas precipitation sums were at the upper tercile threshold. Based on the assessment of the minimum and maximum air temperature (Figure 13) mean minimum and mean maximum air temperature for autumn 2023 were **the highest** in a period from 1951.

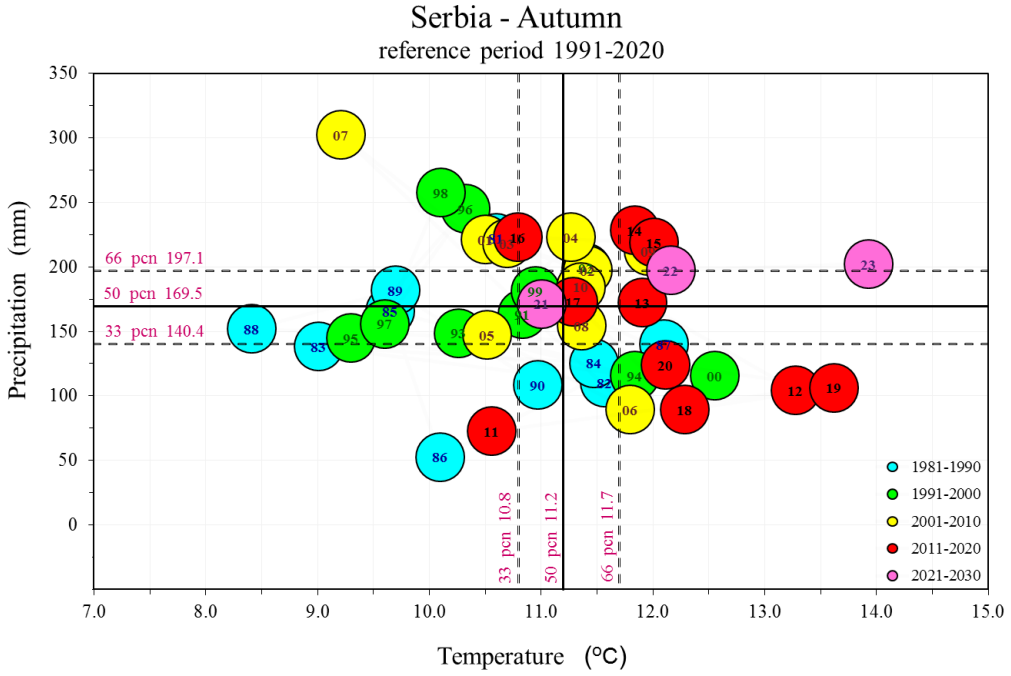



Figure 12. Assessment of mean air temperature and precipitation sums for Autumn in Serbia with the accompanying terciles compared to the 1991-2020 normal

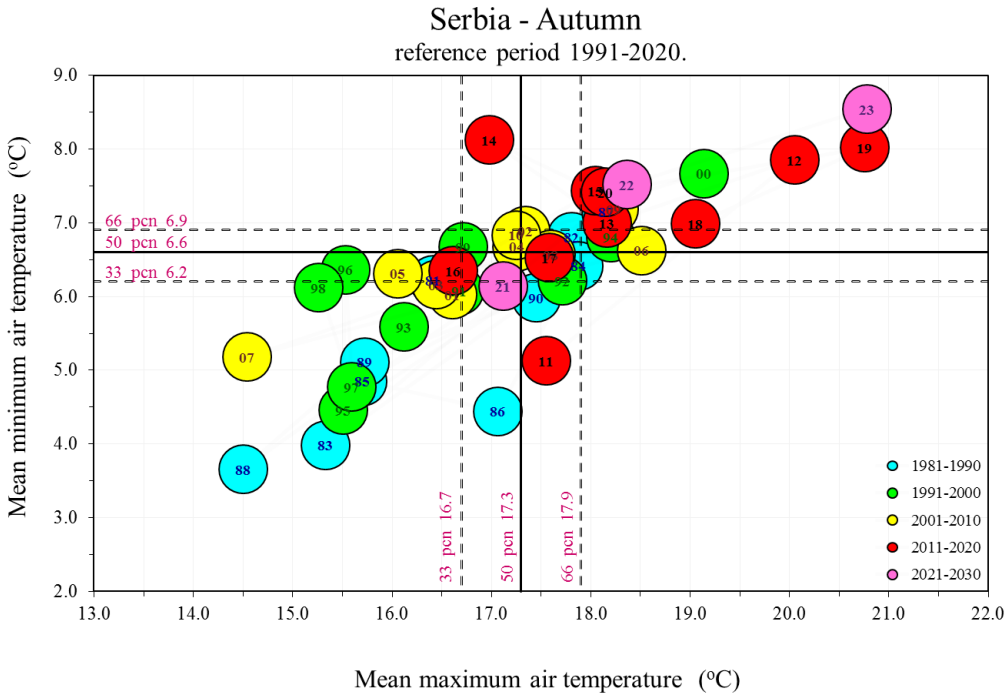
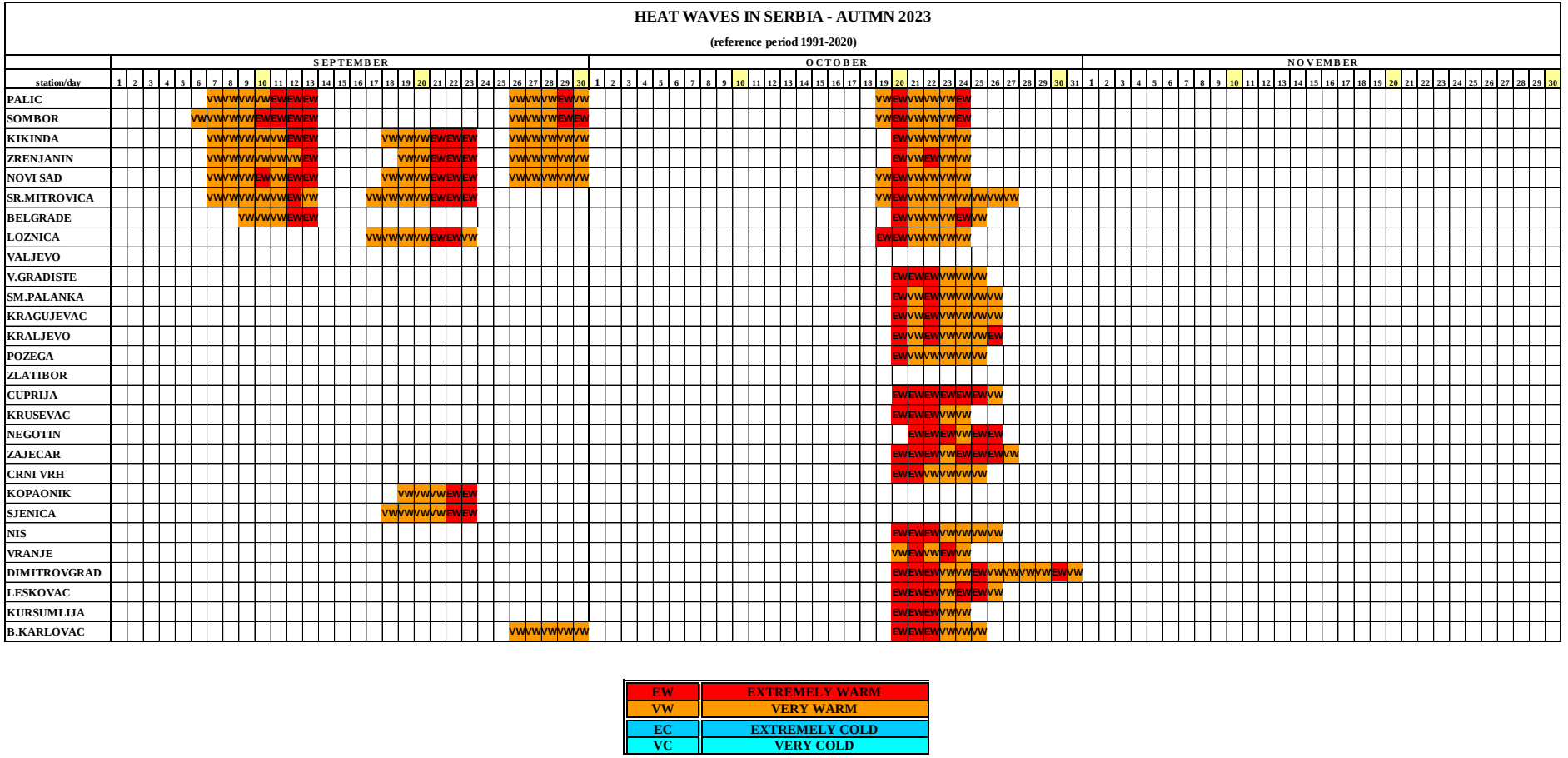



Figure 13. Assessment of minimum and maximum air temperature for Serbia with the accompanying terciles in relation to the 1991-2020 base period

## Heat and cold waves

There were four heat waves[9] during autumn. The first was registered in the period from 7 to 13 September mostly affecting northern areas, the second heat wave lasted from 17 to 23 September in parts of northern and western Serbia, the third heat wave was observed from 26 to 30 September in northern parts of the country, and the fourth heat wave lasted from 20 to 25 October. The longest-lasting heat wave was recorded in Dimitrovgrad between 20 and 31 October (*Chart 3*).

Chart 3.




[9] Heat wave is, according to the percentile method, is a period during which maximum daily air temperature is in the warm and very warm categories for 5 consecutive days or longer

## Precipitation

Autumn precipitation sums in Serbia were around and slightly above the average compared to the normal for the 1991-2020 base period. Precipitation sums ranged from 144,3 mm in Smederevska Palanka to 322,9 mm at Kopaonik (*Figure 14*). Departure of the seasonal precipitation sums from the normal ranged from 90% in Smederevska Palanka to 157% in Negotin (*Figure 15*).

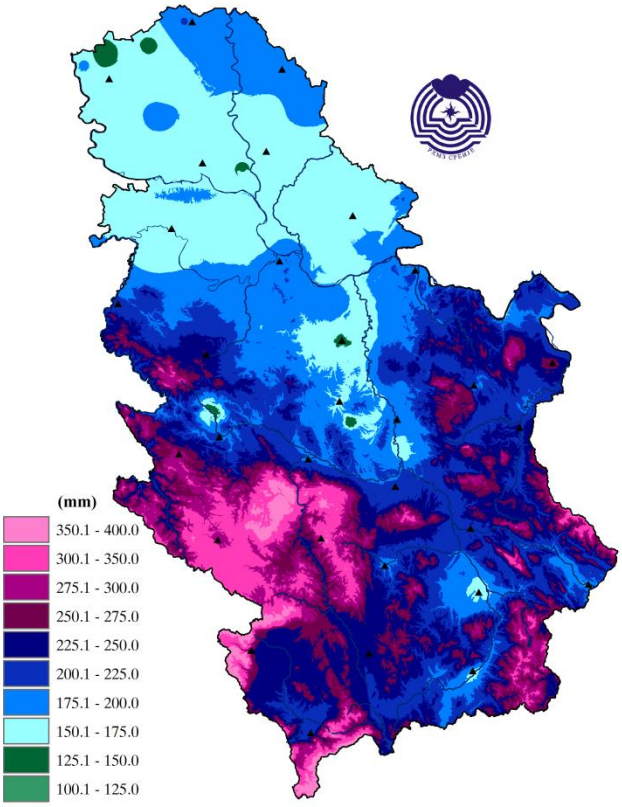



Figure 14. Spatial distribution of the seasonal precipitation sums (mm) according to data from 28 major meteorological, 12 climatological and 47 rain gauge stations

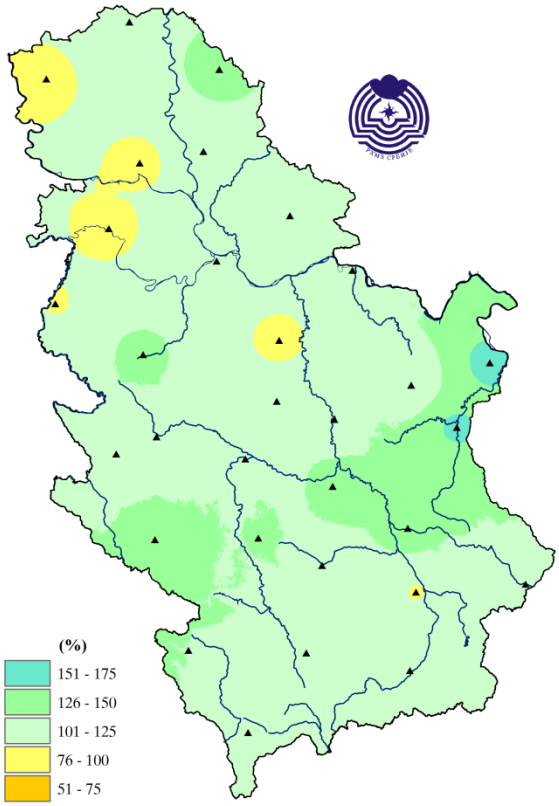



Figure 15. Spatial distribution of the seasonal precipitation sums in the percentages of normal

Based on the percentile method, autumn precipitation sums were in the following categories: normal in most of the country, rainy in Kikinda, Valjevo, Veliko Gradiste, Negotin, Sjenica, Krusevac, Nis, Zajecar and Kopaonik (*Figure 16).*

Precipitation sums based on the tercile method were within the average in most of Serbia, and above the average in the northeast and parts of central, southwestern and eastern Serbia (*Figure 17).*

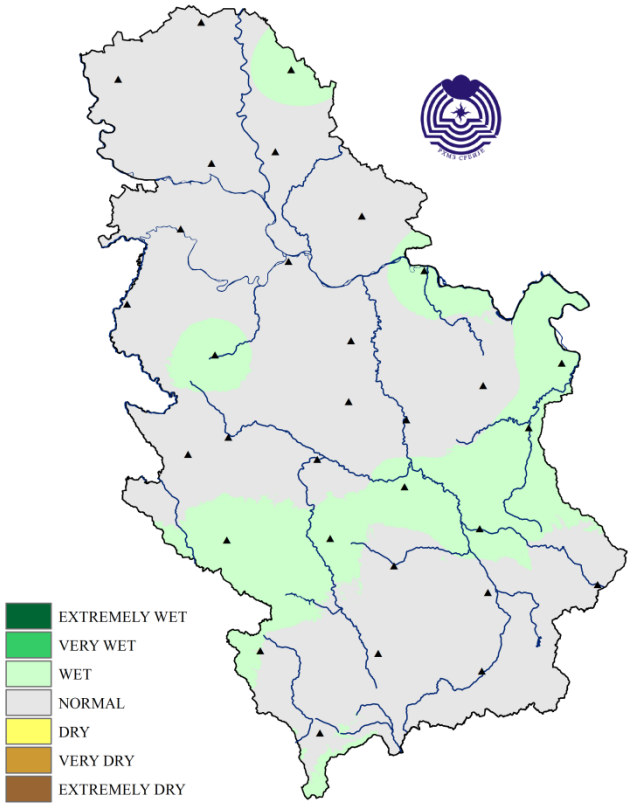



Figure 16. Seasonal precipitation sums according to the percentile method

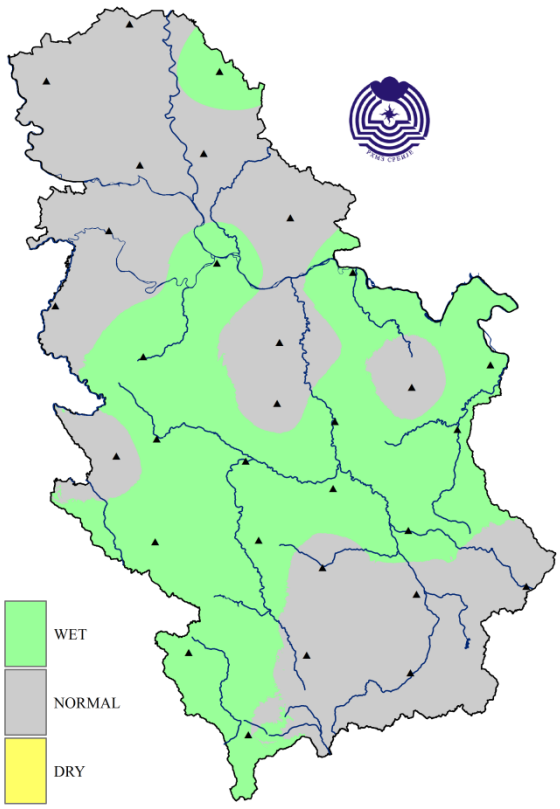



Figure 17. Seasonal precipitation sums according to the tercile method

During autumn, the maximum daily precipitation sum of 67,0 mm was measured in Zrenjanin on September 25 thereby **breaking the previous record of 62,9 mm** set in November 5, 2021. On the same day, Belgrade also recorded the highest daily precipitation sum of 54,2 mm.

Number of days with precipitation of 0,1 mm recorded during autumn ranged from 26 in Novi Sad to 35 days in Kragujevac, Pozega, Cuprija and Leskovac and on the mountains from 36 at Zlatibor to 43 at Kopaonik. The recorded number of days was up to 4 days above the average in the southern, central and northeastern parts of the country, 6 days above the average at Kopaonik and 5 days below the autumn average in the northern and northwestern Serbia (*Figure 18).*

One day with precipitation of 50 mm and higher was recorded in Zrenjanin and Belgrade.

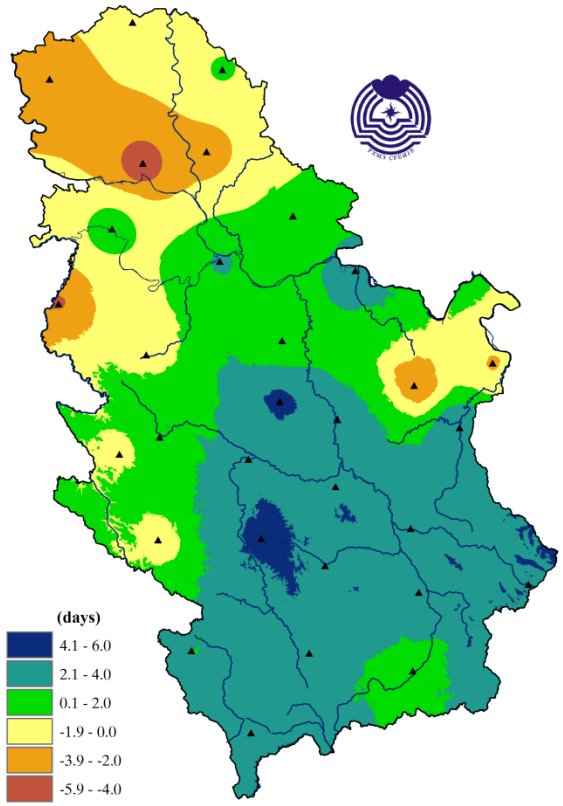



Figure 18. Spatial distribution of deviation of number of days with precipitation

Autumn 2023 ranks as **the 7th wettest** (*Figure 19*) for Sjenica and **the 8th wettest** for Negotin.

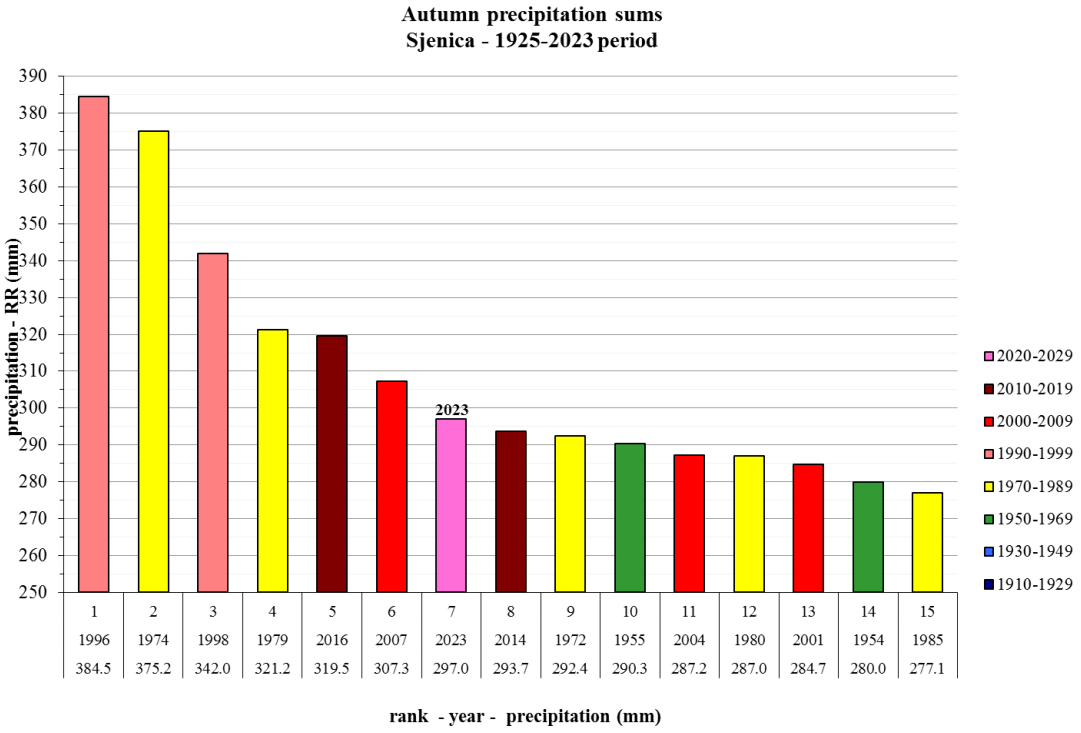



Figure 19. The highest precipitation in Sjenica for the period 1925-2023

At the end of autumn, snow cover was recorded in the southwest, south and southeast of the country. The highest number of days with snow cover (total of 14 days) was recorded at Kopaonik. As for the lowland, the highest number of days with snow cover, total of 3 days, was registered in Leskovac, Dimitrovgrad and Vranje.

The highest snow depth of 43 cm was measured at Kopaonik on November 30. As for the lowland, the highest snow depth of 38 cm was measured in Vranje on November 26. Vranje saw record-breaking snow depth surpassing the previous record of 30 cm set in November 8, 1995.

Figures 20 and 21 show cumulative precipitation sums for Kopaonik and Negotin during autumn per month compared to the average cumulative precipitation sums.

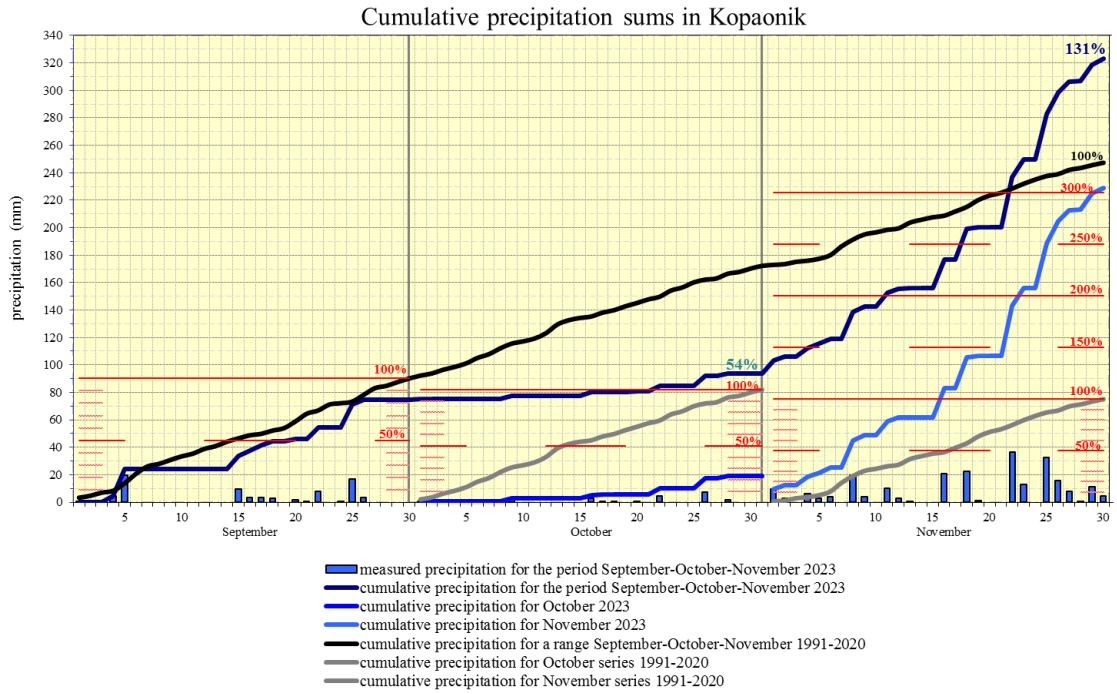



Figure 20. Cumulative precipitation on Kopaonik

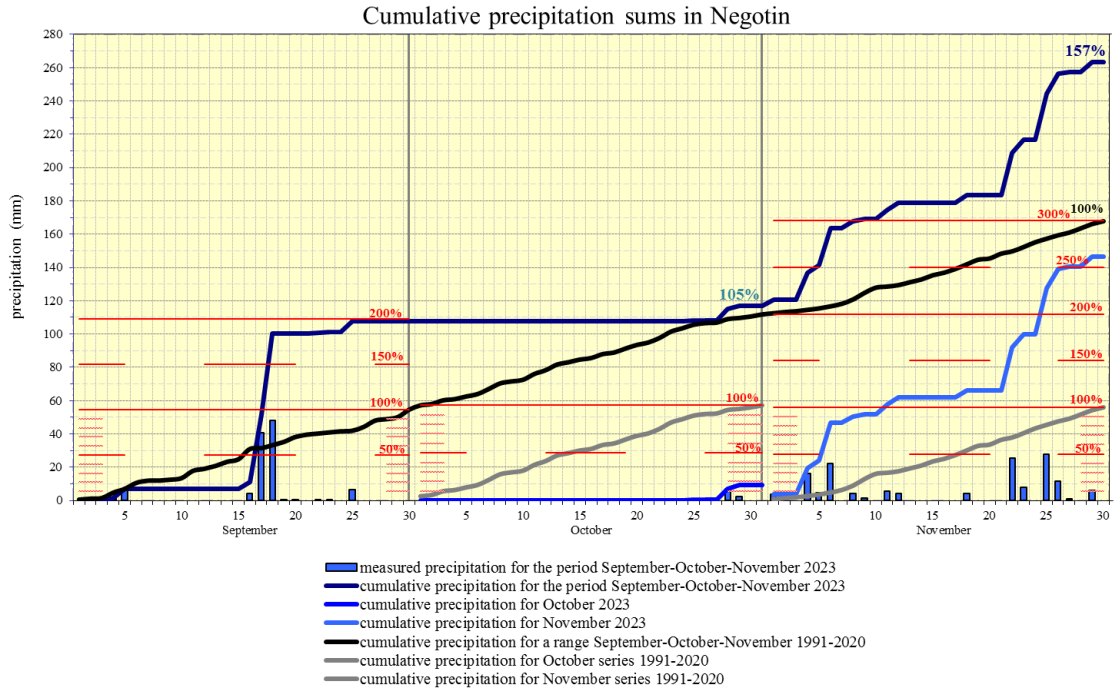



Figure 21. Cumulative precipitation in Negotin

## Sunshine duration (insolation)

Sunshine duration during autumn was within the average. It ranged from 394,8 hours in Pozega to 566,3 hours in Kikinda (*Figure 22*).

Compared to the normal for the 1991-2020 base period, insolation ranged from 94% in Leskovac to 129% in Požega (*Figure 23*).

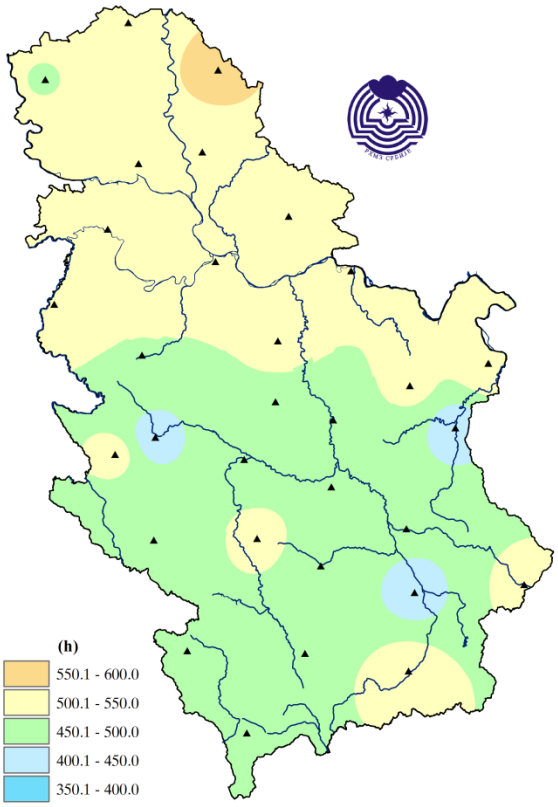



Figure 22. Insolation, expressed in hours

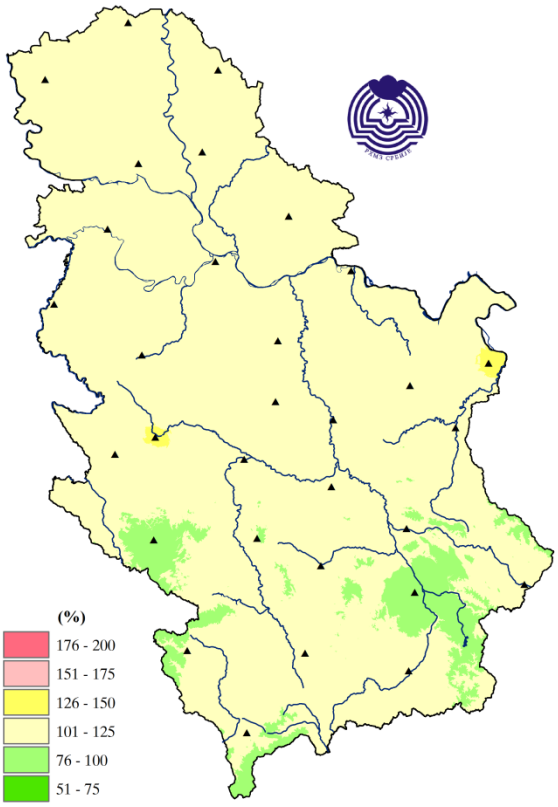



Figure 23. Insolation expressed in the percentages of normal

# Analysis of the autumn 2023 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 +2,6ºC in Veliko Gradište and Zajecar to +4,3ºC in Loznica, and on the mountains from +3,0ºC in Sjenica to +3,5ºC at Crni Vrh (*Figure 24*).

Based on the percentile method, mean air temperature in Serbia was in the extremely warm category (*Figure 25).*

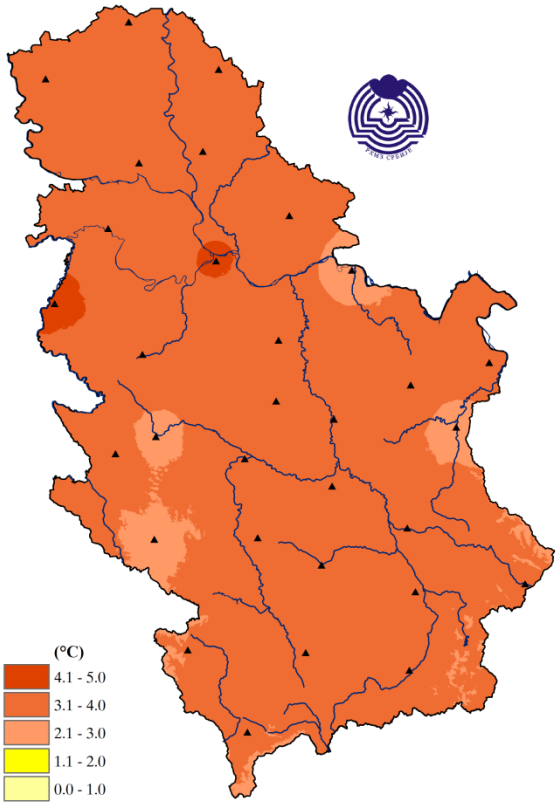



Figure 24. Mean seasonal air temperature anomaly from normal

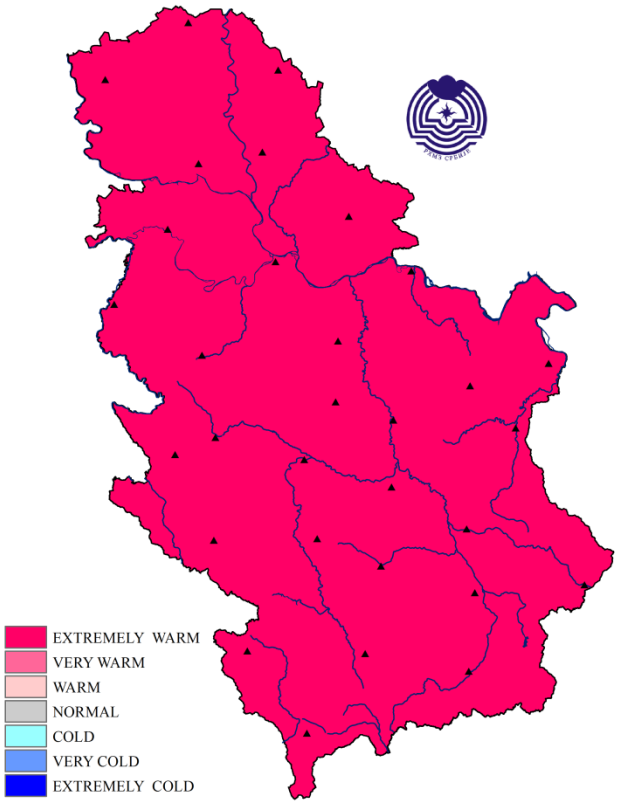



Figure 25. Spatial distribution of mean seasonal air temperature according to the percentile method

## Precipitation

Autumn precipitation sums were in the following categories: above the average in most of Serbia, around the average in parts of western, central and southeastern Serbia compared to the normal for the 1961-1990 base period. Precipitation sums compared to the normal ranged from 103% in Smederevska Palanka to 179% at Kopaonik (*Figure 26).*

Based on the percentile method, autumn precipitation sums were in the following categories: normal and rainy in most of Serbia, very rainy in Zrenjanin, Valjevo, Negotin, Sjenica, Krusevac, Nis and Zajecar, and extremely rainy on Palic, Kopaonik and Kikinda (*Figure 27).*

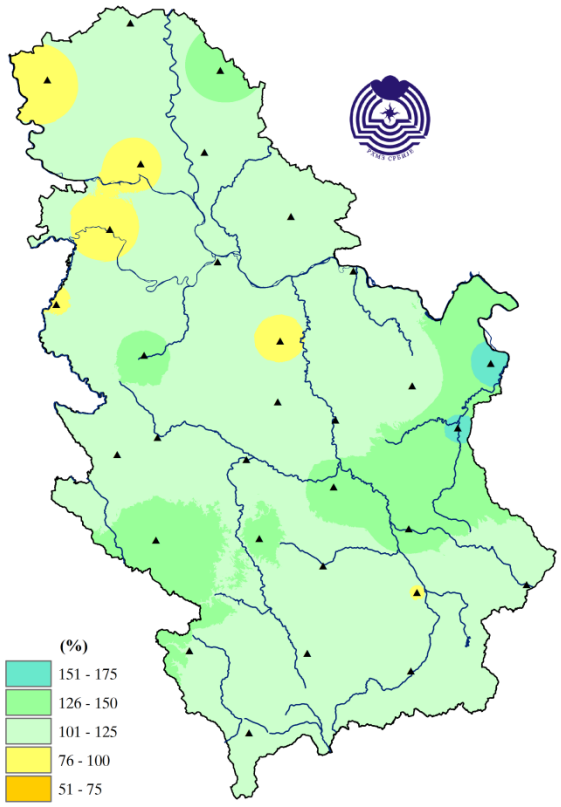



Figure 26. Spatial distribution of seasonal precipitation sums in percentage of normal

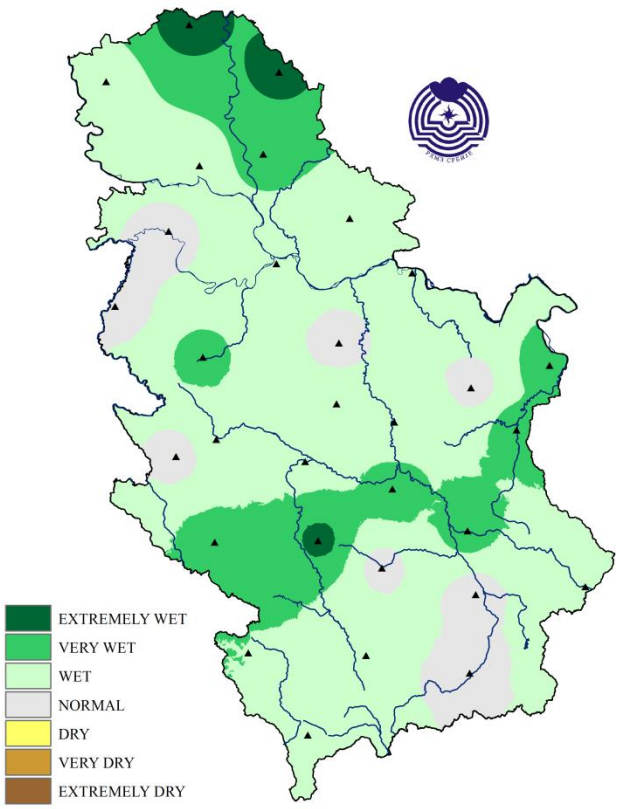



Figure 27. Seasonal precipitation sums according to the percentile method

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