

Republic Hydrometeorological Service of Serbia

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Republic of Serbia



MONTHLY BULLETIN FOR SERBIA

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Belgrade, the 5th of January 2024

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Department of National Center for Climate Change, Climate Model Development and Disaster
Risk Assessment

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- ❖ *3rd warmest December for Serbia since 1951*
- ❖ *Warmest December for Negotin, Valjevo, Zajecar, Loznica and Crni Vrh*
- ❖ *Record-breaking December air temperatures at 13 MMS since record-keeping began*
- ❖ *Record-breaking December daily air temperature since record-keeping began at the beginning and end of month at the majority of the MMS across Serbia*
- ❖ *Summer day in December was recorded in Valjevo, Kragujevac and Kraljevo for the first time since record-keeping began*
- ❖ *One heat wave was observed at the end of the month*

AIR TEMPERATURE

Mean monthly air temperature

December 2023 ranks as the 3rd warmest for the period since 1951 (Figure 1). It was the warmest December for Loznica, Valjevo, Negotin, Zajecar and Crni Vrh since record-keeping at these stations began. At the majority of the main meteorological stations, it was among the 5 warmest (Table 1).

In [appendix](#) are graphs showing 15 warmest years since the record-keeping at the following stations began: Negotin, Valjevo, Crni Vrh, Zajecar, Loznica and Belgrade.

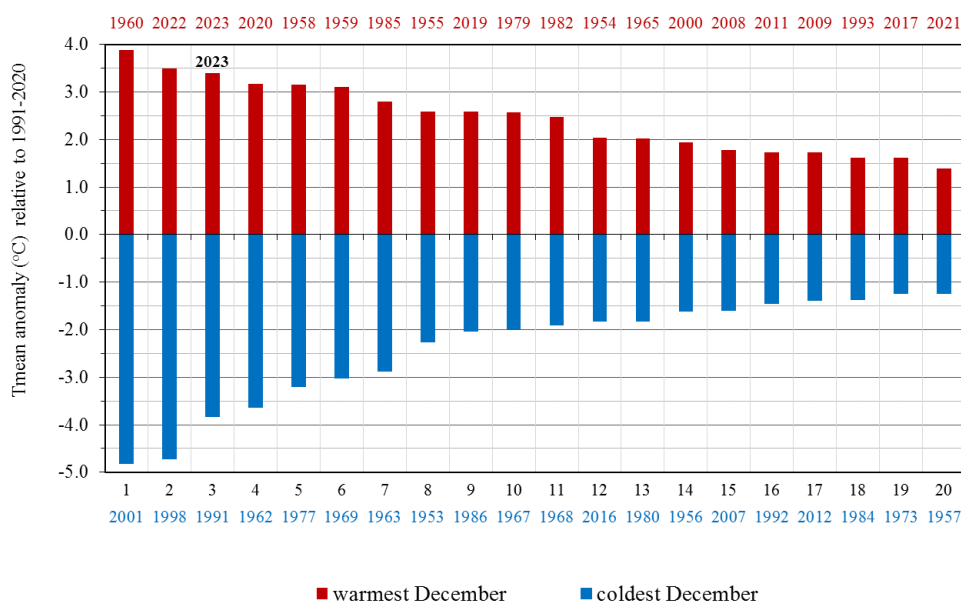


Figure 1. Rank of the warmest and coldest December in Serbia

Table 1. Rank of December 2023 with the mean air temperature, average and departure of the 1991-2020 normal

STATION	historical period	Tmean (°C) - December 2023	1991-2020 base period for December	temperature anomaly (°C)	ranking for December 2023
NEGOTIN	1927-2022	5.8	1.5	4.3	1
VALJEVO	1926-2022	6.4	2.2	4.1	1
CRNI VRH	1966-2022	2.1	-1.9	4.0	1
ZAJECAR	1929-2022	4.7	0.9	3.9	1
LOZNICA	1952-2022	6.3	2.5	3.8	1
BEOGRAD	1887-2022	7.0	3.0	4.0	2
KRALJEVO	1926-2022	5.7	1.8	3.9	2
B.KARLOVAC	1985-2022	5.3	1.9	3.3	2
KOPAONIK	1949-2022	0.0	-3.2	3.2	2
KRAGUJEVAC	1925-2022	6.3	2.4	3.9	3
CUPRIJA	1948-2022	5.7	1.8	3.9	3
ZLATIBOR	1950-2022	3.0	-0.9	3.9	3
NOVI SAD	1948-2022	5.3	1.8	3.5	4
KIKINDA	1948-2022	4.8	1.5	3.3	4
POZEGA	1952-2022	3.2	-0.1	3.2	4
SJENICA	1946-2022	1.9	-2.0	3.9	5
S.PALANKA	1939-2022	5.6	2.2	3.4	5
KRUSEVAC	1930-2022	5.2	1.8	3.4	5
ZRENJANIN	1943-2022	5.0	1.8	3.2	5
KURSUMLIJA	1952-2022	4.9	1.6	3.3	6
NIS	1925-2022	5.5	2.3	3.2	7
S.MITROVICA	1925-2022	4.7	1.6	3.0	7
V.GRADISTE	1926-2022	4.4	1.7	2.7	8
VRANJE	1926-2022	4.3	1.5	2.7	8
SOMBOR	1941-2022	4.1	1.4	2.7	8
DIMITROVGRAD	1945-2022	3.7	1.0	2.6	8
PALIC	1945-2022	3.7	1.2	2.6	10
LESKOVAC	1948-2022	4.0	1.7	2.3	13

Mean air temperature in December ranged from 3,2°C in Pozega to 7,0°C in Belgrade, and on the mountains from 0,0°C at Kopaonik to 3,0°C at Zlatibor (*Figure 1*).

Departure of the mean monthly air temperature from the normal¹ for the 1991–2020 base period ranged from +2,3°C in Leskovac to +4,3°C in Negotin (*Figure 2*).

December mean air temperature, based on the percentile method², was in the category of extremely warm across most of the country, very warm in Sombor, Veliko Gradiste, Dimitrovgrad, Vranje and Palic, and warm category in Leskovac (*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, 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

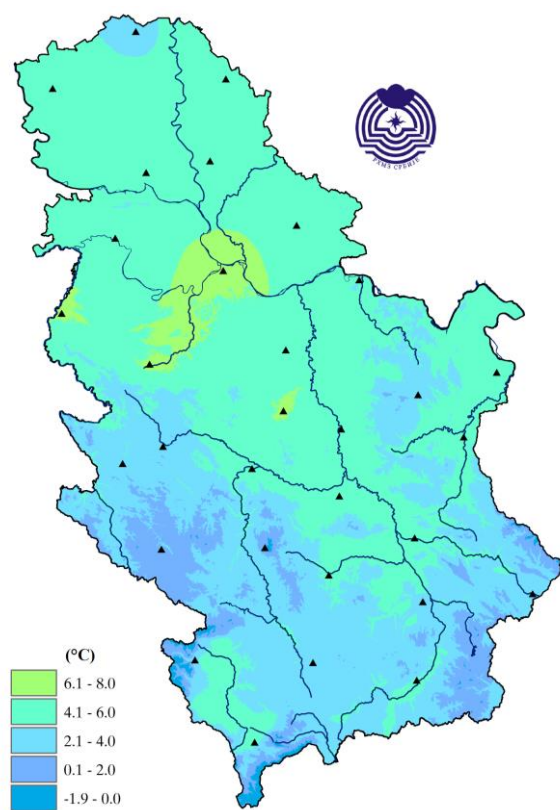


Figure 2. Spatial distribution of mean monthly air temperature (°C)

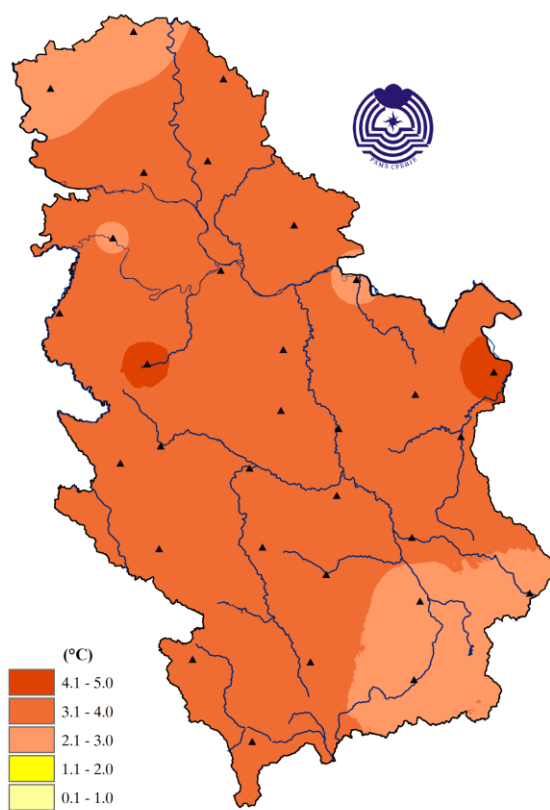


Figure 3. Spatial distribution of mean monthly air temperature anomaly (°C)

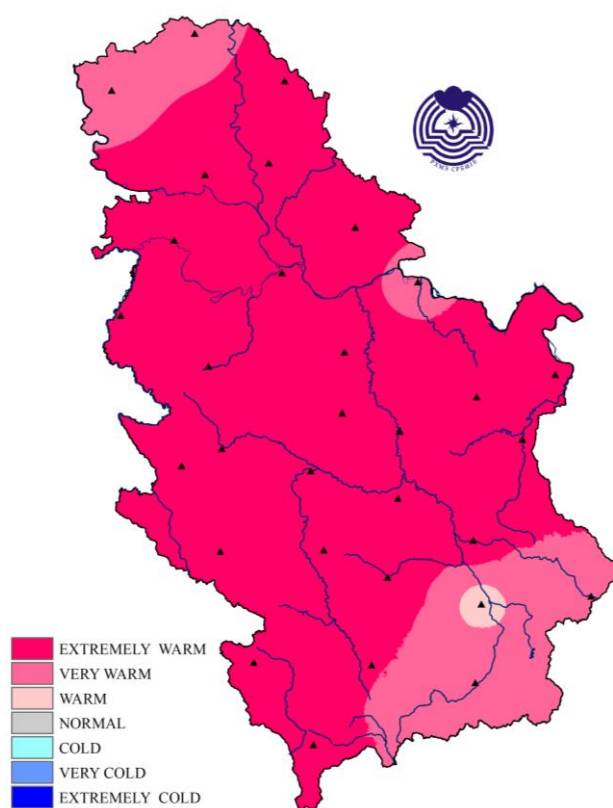


Figure 4. Spatial distribution of the mean monthly air temperature using percentile method

Mean daily air temperature in Belgrade, based on the percentile method, was in the categories of warm and very warm most of the month. At the beginning of the month as well as at the beginning of the second decade, it was in the extremely warm category, whereas it was in the normal category during most of the first decade (*Figure 5*). Daily course of the mean daily air temperature and the accompanying percentiles for the stations Sombor, Novi Sad, Loznica, Negotin, Kragujevac, Zlatibor, Nis and Vranje are given in the [Appendix](#).

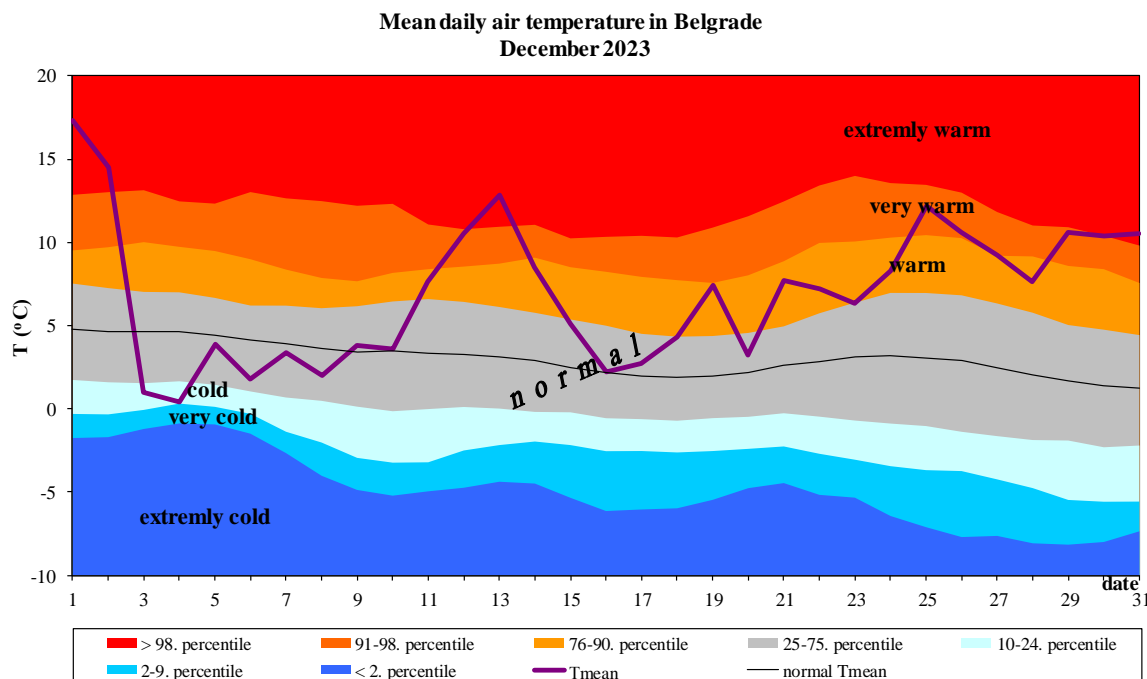


Figure 5. Daily course of the mean daily air temperature and accompanying percentiles for Belgrade

Maximum air temperature

Mean maximum air temperature in December ranged from 8,0°C on Palic to 12,7°C in Valjevo, whereas Belgrade observed air temperature of 11,4°C. On the mountains, mean maximum December air temperature ranged from 3,8°C at Kopaonik to 7,9°C in Sjenica.

Based on the percentile method, mean maximum monthly air temperature was in the extremely warm category in most of the country, and very warm at Kopaonik.

December records are broken at 13 main meteorological stations (*Table 2*). In Serbia, the highest maximum daily air temperature of 25,6°C was measured in Valjevo on December 2. On the same day, Belgrade observed 22,7°C.

Table 2. Record-breaking December air temperatures

MMS	2023		Previous record Aps Tmax	date Aps Tmax
	Tmax December 2023	date Tmax		
VALJEVO	25.6	2	23.8	25. XII 2009.
KRAGUJEVAC	25.2	2	22.2	16. XII 2022.
KRALJEVO	25.0	2	24.4	13. XII 1957.
KRUSEVAC	24.0	2	22.4	13. XII 1957.
POZEGA	23.4	2	23.0	25. XII 2009.
S.MITROVICA	22.8	2	22.0	19. XII 1989.
BEOGRAD	22.7	2	22.6	16. XII 1989.
LESKOVAC	22.5	2	21.7	18. XII 1958.
CUPRIJA	22.0	2	21.4	9. XII 2010.
NOVI SAD	21.6	1	21.0	17,19. XII 1989.
KURSUMLIJA	21.5	2	21.2	31. XII 2009.
NEGOTIN	21.3	26	20.6	18. XII 1989.
VRANJE	20.4	2	20.0	1.2. XII 1938.

Record-breaking daily air temperatures in December since the record-keeping began at the majority of the main stations were measured on December 1 and 2, and then on December 25, 26 and 28.

One summer day³ was recorded in Valjevo, Kragujevac and Kraljevo on December 2, **for the first time in** December since record-keeping at these stations began.

Number of ice days⁴ was the following: Crni Vrh – 8 days, Kopaonik – 5 days, Zlatibor – 3 days, Sjenica – 2 days, Palic and Loznica – 1 day.

Heat wave⁵ was recorded in most of the country on December 24 and 25, continuing throughout the beginning of January (*Table 3*).

³ Summer day refers to a day with maximum daily air temperature 25°C and above

⁴ Ice day is defined as the day with maximum air temperature lower than 0°C

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

Table 3. Heat waves in Serbia

HEAT WAVES IN SERBIA - DECEMBER 2023																																			
(relative to the 1991-2020 base period)																																			
DECEMBER																																			
stanica/dan	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																										EW	EW	VW	VW	EW	EW				
SOMBOR																										EW	EW	VW	VW	EW	EW				
KIKINDA																										EW	EW	VW	VW	EW	EW				
ZRENJANIN																									VW	EW	VW	VW	VW	EW	EW				
NOVI SAD																										EW	VW	VW	VW	VW	EW	EW			
SR.MITROVICA																										EW	EW	VW	VW	EW	EW				
BEOGRAD																															VW	EW	EW		
LOZNICA																																			
VALJEVO																															VW	EW	VW	EW	
V.GRADISTE																															EW	VW	VW	VW	
SM.PALANKA																										EW	EW	VW	VW	EW	VW	VW	VW		
KRAGUJEVAC																															VW	VW	VW	VW	
KRALJEVO																																			
POZEGA																																			
ZLATIBOR																																			
CUPRIJA																										VW	EW	EW	VW	EW					
KRUSEVAC																										VW	EW	VW	VW	VW	VW	VW	VW	VW	
NEGOTIN																											EW	EW	EW	VW	EW	EW	EW	EW	
ZAJECAR																																			
CRNI VRH																															EW	EW	VW	VW	
KOPAONIK																											VW	EW	VW	EW	EW				
SJENICA																											VW	EW	EW	EW	EW	EW	VW	VW	
NIS																																			
VRANJE																											EW	EW	VW	VW	VW	VW	VW	VW	
DIMITROVGRAD																																			
LESKOVAC																																			
KURSUMLIJA																											EW	EW	VW	VW	VW	VW	VW	VW	
B.KARLOVAC																																EW	EW	VW	EW

EW

VW

EXTREMELY WARM

VERY WARM

EW	EXTREMELY WARM
VW	VERY WARM

Figure 6 shows daily course of the maximum daily air temperature and the accompanying percentiles for Belgrade in December 2023 and for the stations Sombor, Novi Sad, Loznica, Negotin, Kragujevac, Zlatibor, Nis and Vranje are given in the [Appendix](#).

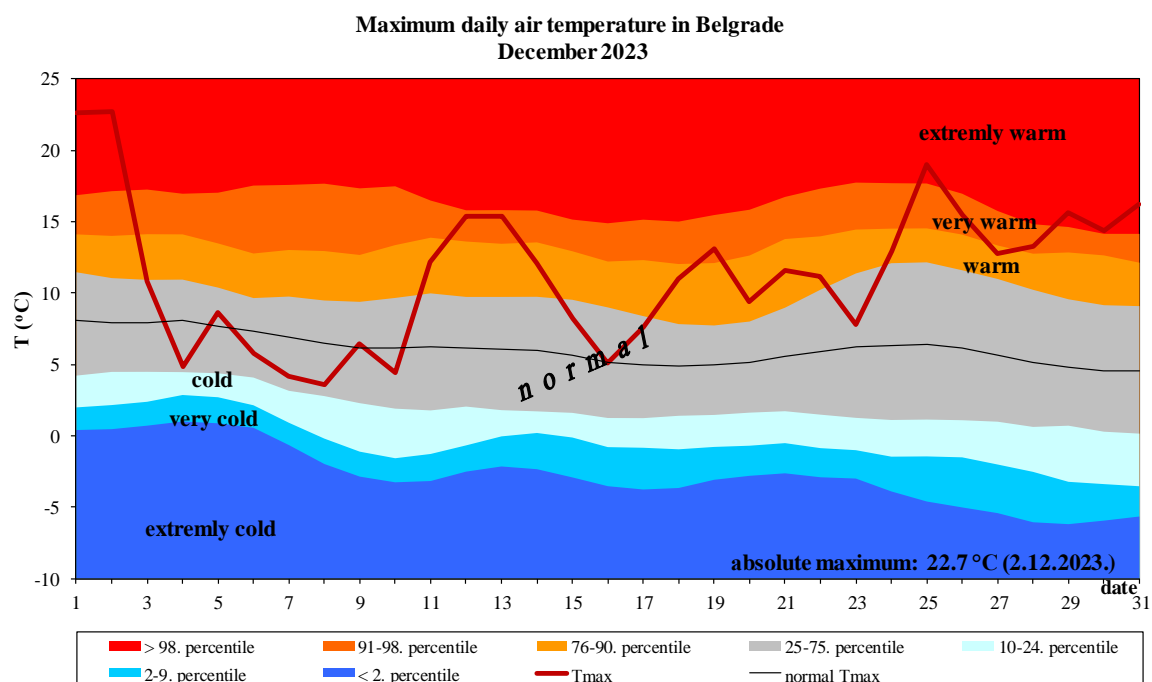


Figure 6. Daily course of the maximum daily air temperature and accompanying percentiles for Belgrade

Minimum air temperature

Mean minimum air temperature in December ranged from $-0,7^{\circ}\text{C}$ in Pozega to $3,4^{\circ}\text{C}$ in Belgrade. On the mountains, mean minimum air temperature ranged from $-3,2^{\circ}\text{C}$ at Kopaonik to $-0,1^{\circ}\text{C}$ at Zlatibor.

Based on the percentile method, mean minimum monthly air temperature was in the categories of very warm and extremely warm in most of the country, warm category on Palic, Sombor, Dimitrovgrad and Vranje, and normal category in Leskovac.

The lowest minimum daily air temperature of $-10,5^{\circ}\text{C}$ was measured at Kopaonik on December 17. The lowest daily air temperature in the lowland was measured in Veliko Gradiste on December 4 amounting to $-7,3^{\circ}\text{C}$. On the same day, Belgrade observed the lowest monthly air temperature of $-3,9^{\circ}\text{C}$.

In most of the country, there were between 10 and 17 frost days⁶, Belgrade observed 4 days, Negotin observed 8 days, and Pozega observed 22 frost days. In the upland, number of frost days ranged from 18 days at Vrnji Vrh and Zlatibor to 25 days in Sjenica. The recorded number of frost days was 3 to 10 days below December average in most of the country.

Kopaonik recorded one day with severe frost⁷.

Figure 7 shows assessment of the minimum and maximum air temperature for Serbia for December based on the tercile distribution compared to the 1991-2020 base period. It can be noted that the mean minimum and mean maximum air temperature were significantly above the upper tercile threshold, in terms of the maximum air temperature it ranks as the warmest December and in terms of the minimum air temperature, it ranks as the 3rd warmest since 1981.

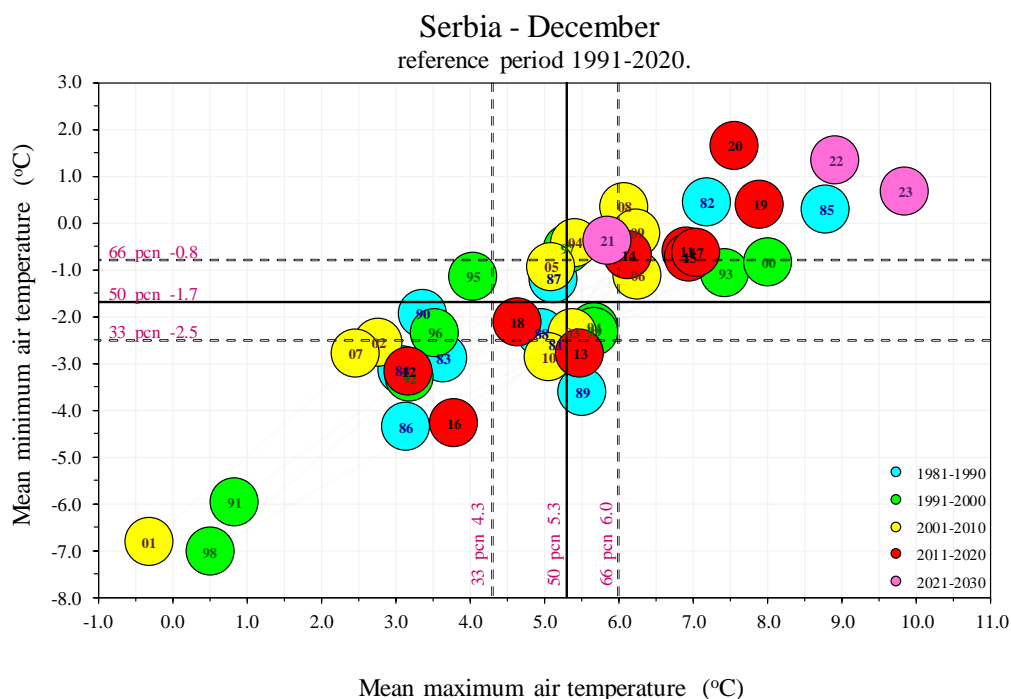


Figure 7. Assessment of minimum and maximum air temperature for Serbia with the accompanying terciles in relation to the 1991-2020 base period

⁶ Frost day is defined as the day with minimum air temperature lower than 0°C

⁷ Day with severe frost is defined as the day with the minimum air temperature -10°C and below

Figure 8 shows daily course of the minimum daily air temperature and the accompanying percentiles for Belgrade in December 2023, and for the stations Sombor, Novi Sad, Loznica, Negotin, Kragujevac, Zlatibor, Nis and Vranje are given in the [Appendix](#).

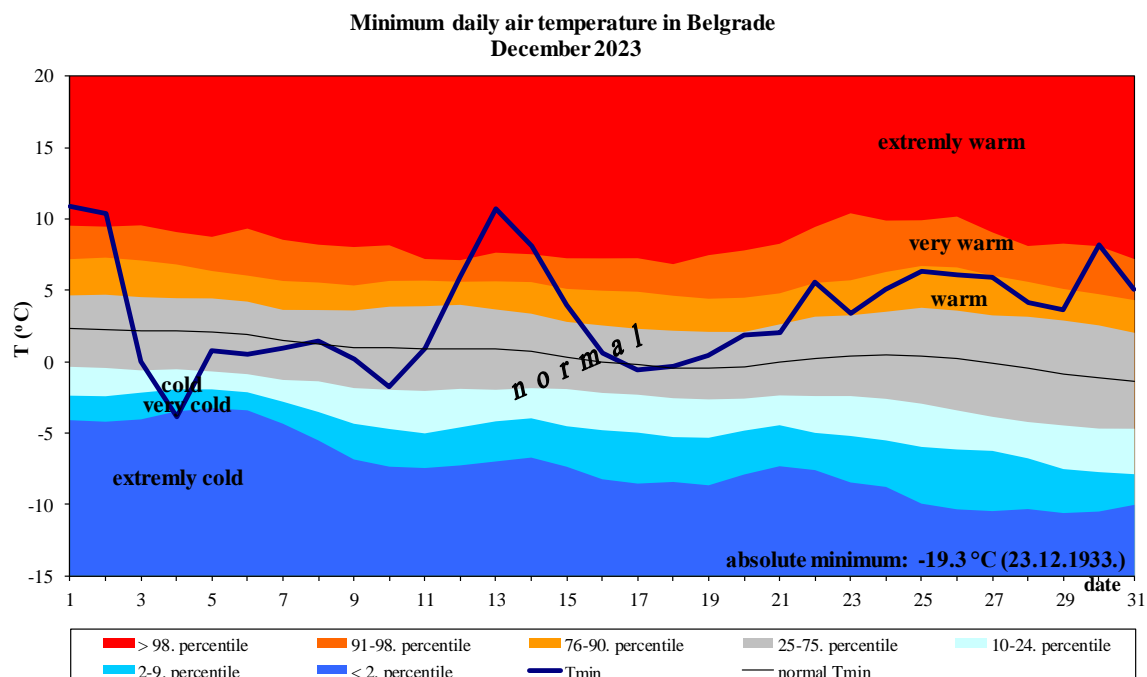


Figure 8. Daily course of the minimum daily air temperature and accompanying percentiles for Belgrade

PRECIPITATION

December precipitation sums ranged from 20,5 mm in Negotin to 99,0 mm at Kopaonik, whereas Belgrade observed 33,3 mm of precipitation (*Figure 9*).

Total precipitation sums compared to the normal for the 1991-2020 base period ranged from 33% in Negotin to 150% on Palic (*Figure 10*).

Based on the percentile method, precipitation sums were in the categories of normal and dry in most of the country, and rainy on Palic (*Figure 11*).

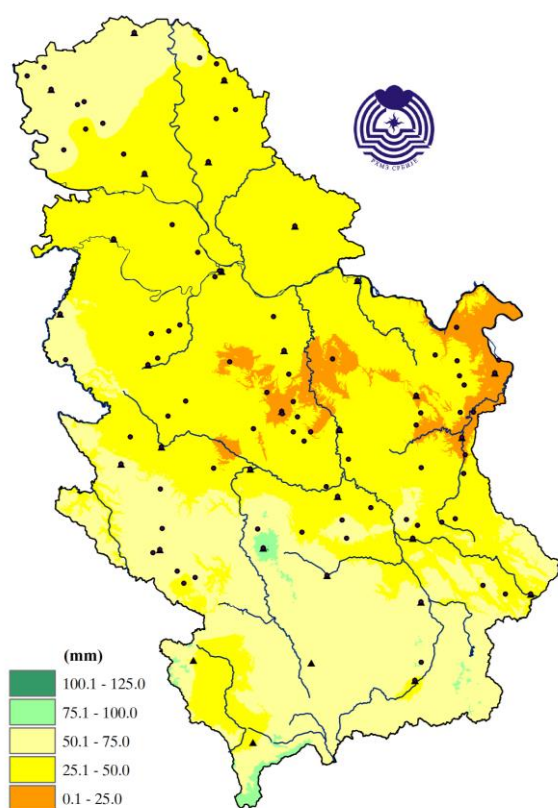


Figure 9. Spatial distribution of the monthly precipitation sums (mm) according to data from 28 major meteorological, 25 climatological and 45 rain gauge stations

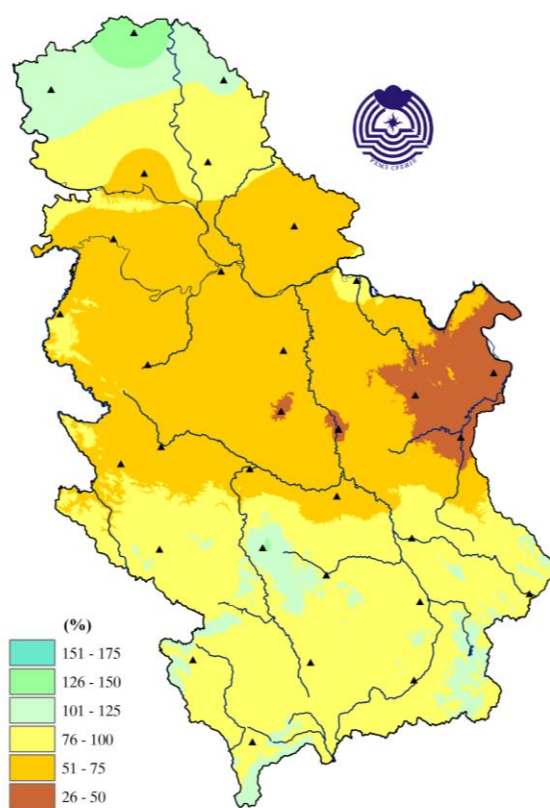


Figure 10. Spatial distribution of the monthly precipitation sums in the percentages of normal for the 1991–2020 base period

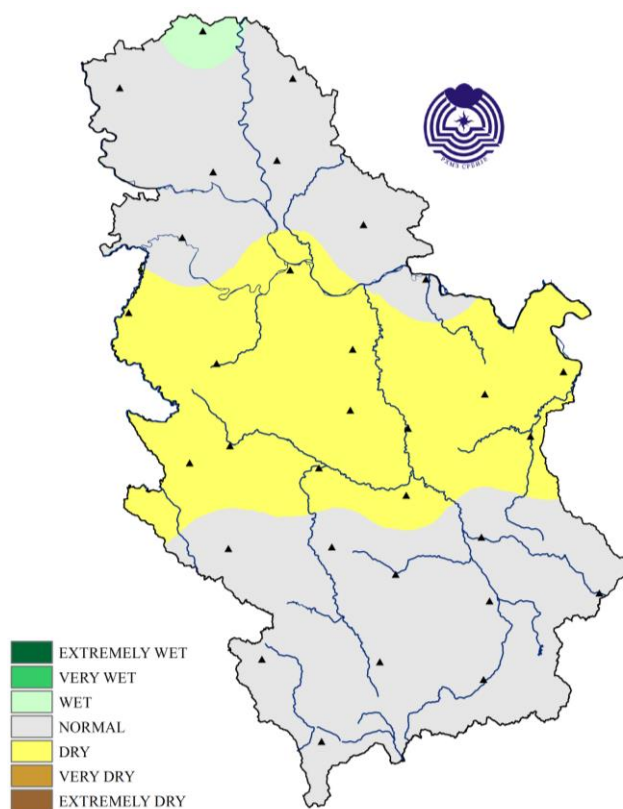


Figure 11. Monthly precipitation sums according to the percentile method

The highest daily precipitation sum of 40,3 mm was measured at Kopaonik on December 15. On December 14, Belgrade observed the highest daily precipitation sum of 12,6 mm.

Number of days with precipitation in December ranged from 8 to 13 (*Figure 12*) and it was 7 days below December average (*Figure 13*).

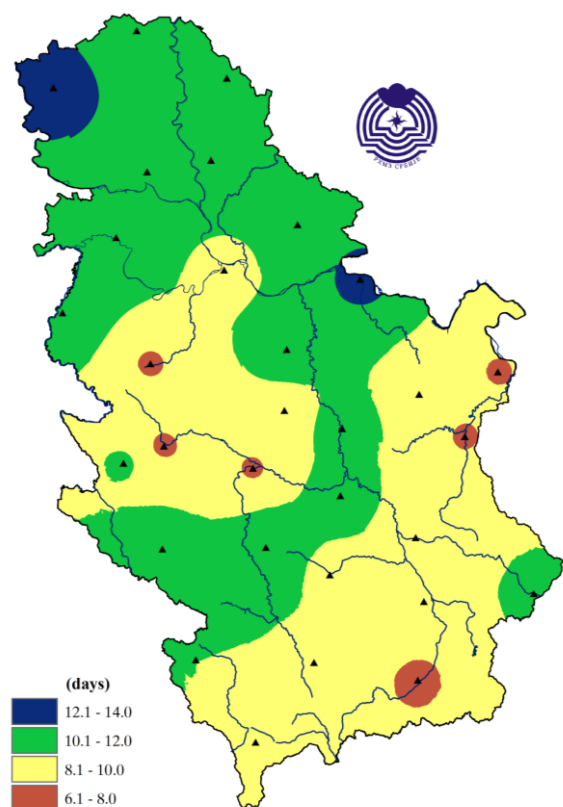


Figure 12. Spatial distribution of number of days with precipitation

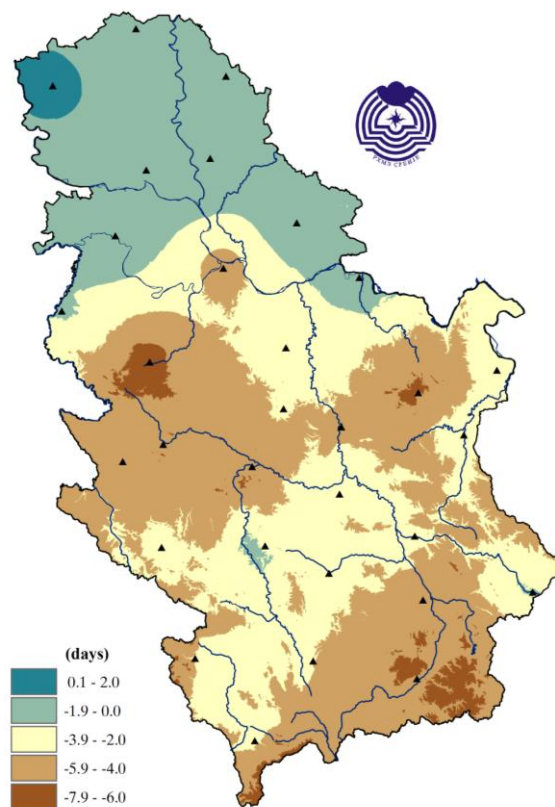


Figure 13. Spatial distribution of deviation of number of days with precipitation

Aside from the mountains, on December 7, snow cover was recorded in Sombor, Loznica, Nis, Zajecar, Dimitrovgrad and Palic. The highest snow depth of 39 cm was measured at Kopaonik on December 23. As for the low-lying areas, the highest snow depth was measured in Loznica on December 7.

The highest number of days with snow cover was recorded at Kopaonik, total of 27 days, whereas only 1 day with snow cover was registered in the low-lying areas.

Figure 14 shows assessment of the air temperature and precipitation sums for Serbia for December based on the tercile distribution compared to the 1991-2020 base period. It can be noted that December 2023 was marked by air temperature significantly above the upper tercile threshold (the 2nd warmest since 1981) with precipitation sums at the lower tercile threshold.

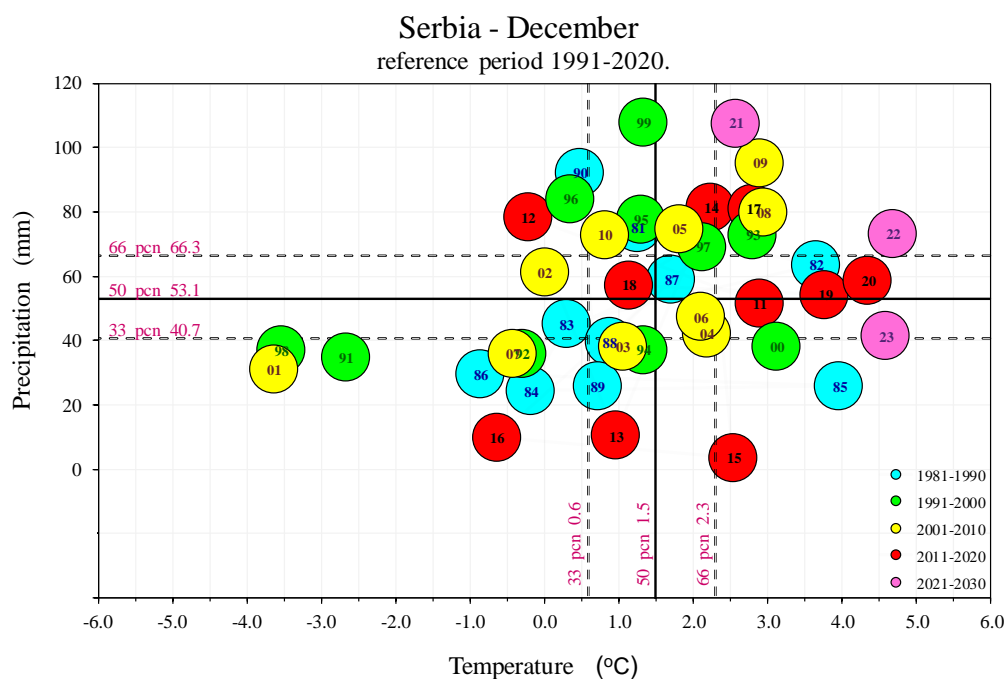


Figure 14. Assessment of air temperature and precipitation for Serbia with the accompanying terciles in relation to the 1991-2020 base period

Figure 15 show daily and cumulative precipitations sums with averaged normal 1991-2020 for December in Belgrade, and for the stations Sombor, Novi Sad, Loznica, Negotin, Kragujevac, Zlatibor, Nis and Vranje precipitation sums are given in [Appendix](#).

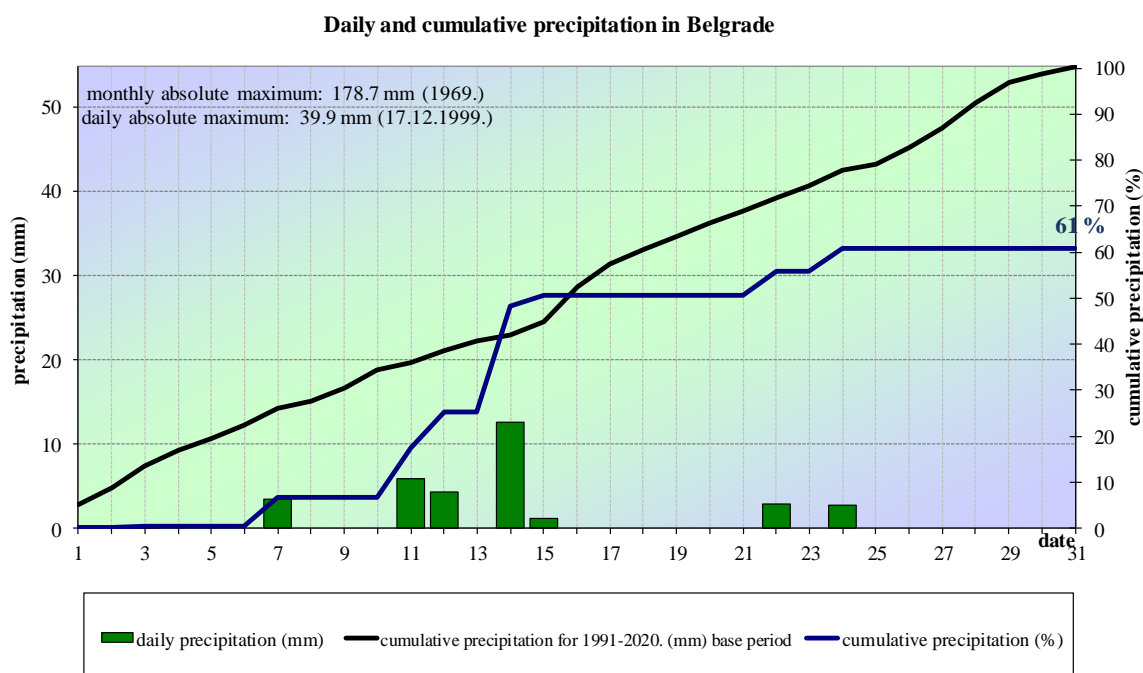


Figure 15. Daily and cumulative precipitation in Belgrade

CLOUD COVER, BRIGHT AND CLOUDY DAYS

Mean December cloud cover in Serbia was slightly below the average, ranging from 5/10 to 6/10. Figures 16, 17 and 18 show average daily cloud cover in Belgrade, Pozega and Sombor.

Number of bright days⁸ ranged from 5 in Sjenica, Pozega and Kraljevo to 9 in Banatski Karlovac, Sremska Mitrovica, Nis and Kopaonik. Belgrade observed 6 bright days. The observed number of bright days was 2 to 6 days above the December average.

The lowest number of cloudy days⁹ was recorded in Belgrade, total of 7 days, whereas Zajecar observed the highest number of cloudy days, total of 16. Number of cloudy days was 3 to 9 days below December average in most of the country.

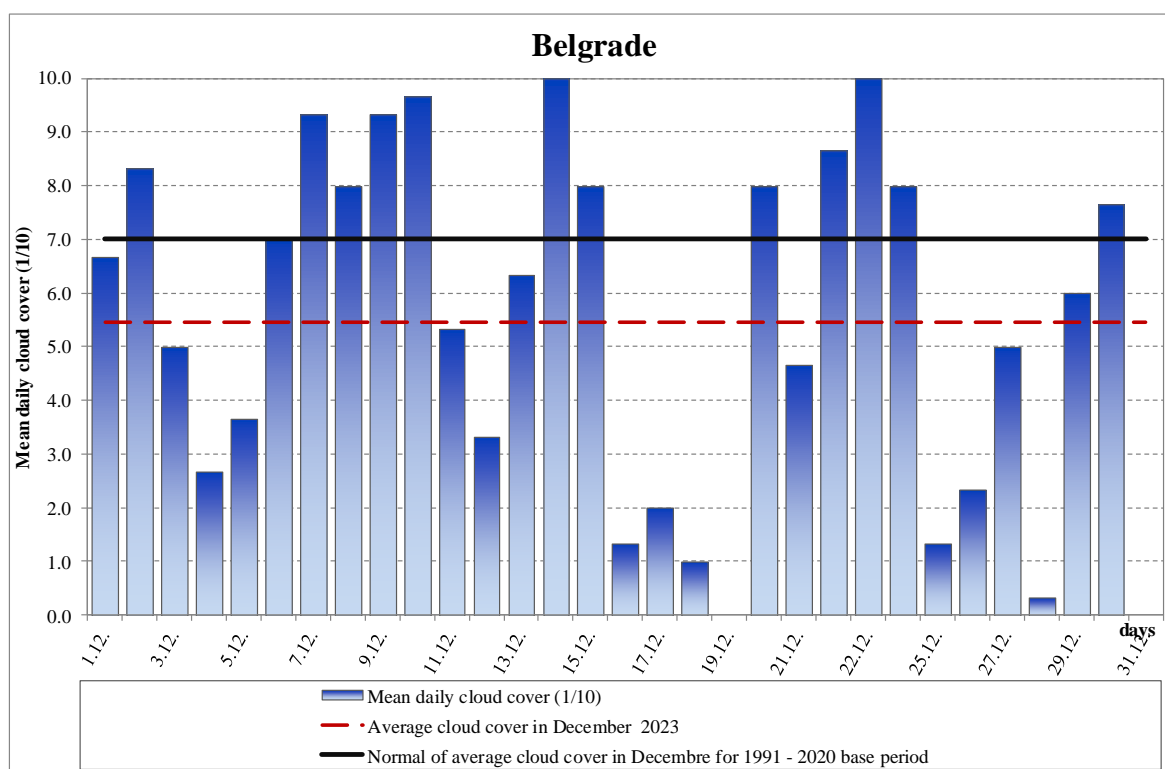


Figure 16. Mean daily cloud cover in Belgrade

⁸ Bright day refers to a day with cloud cover less than 2/10

⁹ Cloudy day refers to a day with cloud cover over 8/10

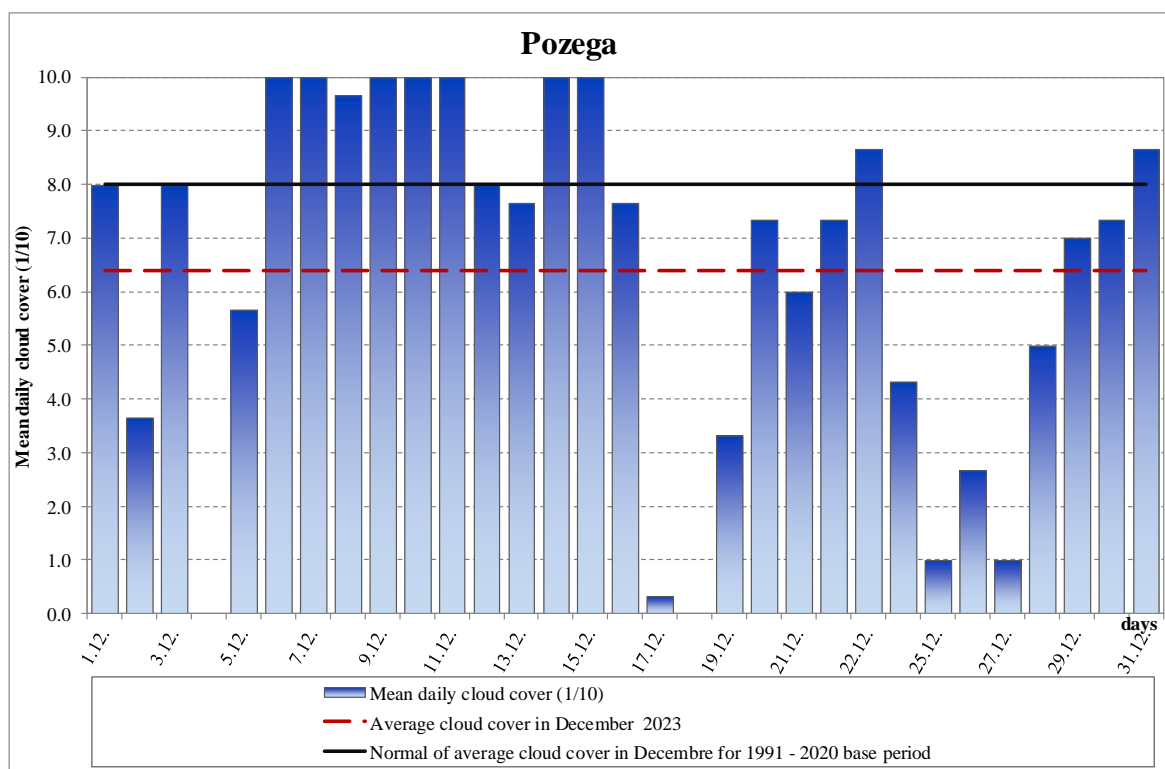


Figure 17. Mean daily cloud cover in Pozega

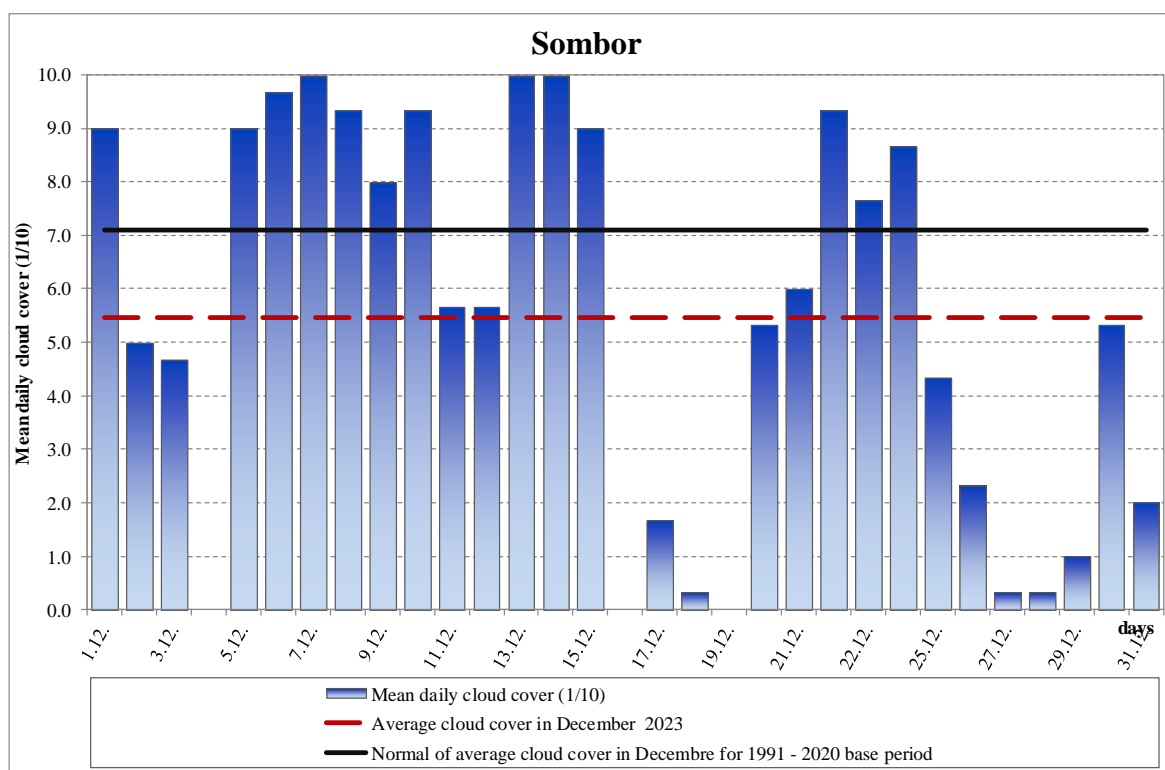


Figure 18. Mean daily cloud cover in Sombor

SUNSHINE DURATION (INSOLATION)

Sunshine duration in December ranged from 67,7 hours in Pozega to 107,7 hours in Krusevac (*Figure 19*).

December insolation ranged from 111% at Zlatibor to 213% in Krusevac compared to the normal for the 1991-2020 base period (*Figure 20*).

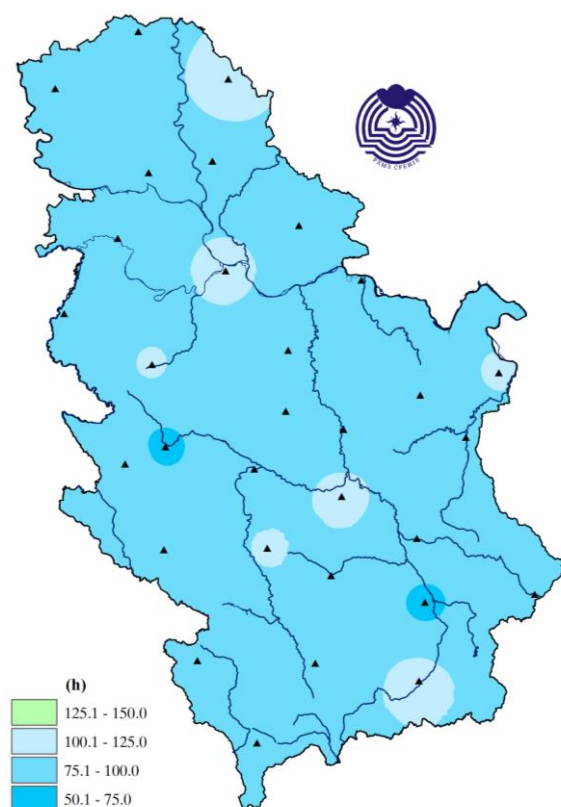


Figure 19. Insolation, expressed in hours

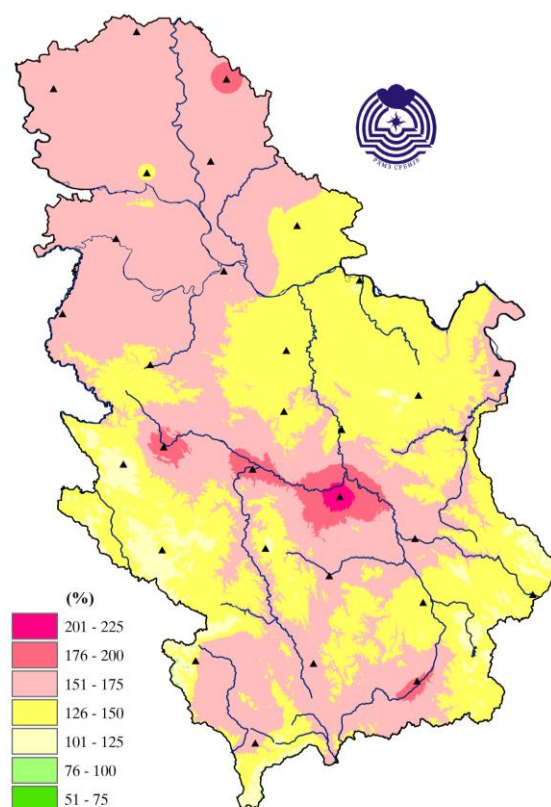


Figure 20. Insolation expressed in the percentages of normal

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

OVERVIEW OF THE SYNOPTIC SITUATION*

Periodically significant impacts of low pressure and accompanying frontal waves from the north and west-southwest of the continent as well as brief noticeable cooling at the beginning of the month, occasional snow in low-lying areas; most of the month warm and extremely warm, with high geopotential values and polar jet streams farther north of the Balkan Peninsula.

On the second day of the month, following warm weather on the front side of a spatial low pressure from the west and southwest of the continent, there was a change in weather conditions. Specifically, the influence of the low pressure and the waves of cold and wet air within it from the northwest, as well as their movement across our country towards the east, resulted in significantly colder weather than in the previous days, locally with rain and showers, occasionally accompanied by thunderstorms, in the northern regions at first, then elsewhere. By the end of the first decade, chilly weather persisted with occasional light rain, and in the west, north, and southwest, as well as in low-lying areas, light snowfall was observed under the influence of cold air and upper air circulation, which slowly filled and moved eastward and southeastward.

During the second decade, it was warmer than the previous days, with changeable cloudiness in the first part, occasionally accompanied by rain and showers. This occurred due to the development of a new low pressure in the eastern Atlantic, the establishment of west-southwest upper-level circulation, an increase in geopotential over the Balkans, and the influence and passage of waves of moist air within the aforementioned field of low air pressure and upper-air circulation. Then, towards the end of the second decade, a weak ridge was established, along with a surface anticyclone, resulting in dry and still relatively warm weather. In some lowlands and valleys, there was prolonged fog lingering during the day.

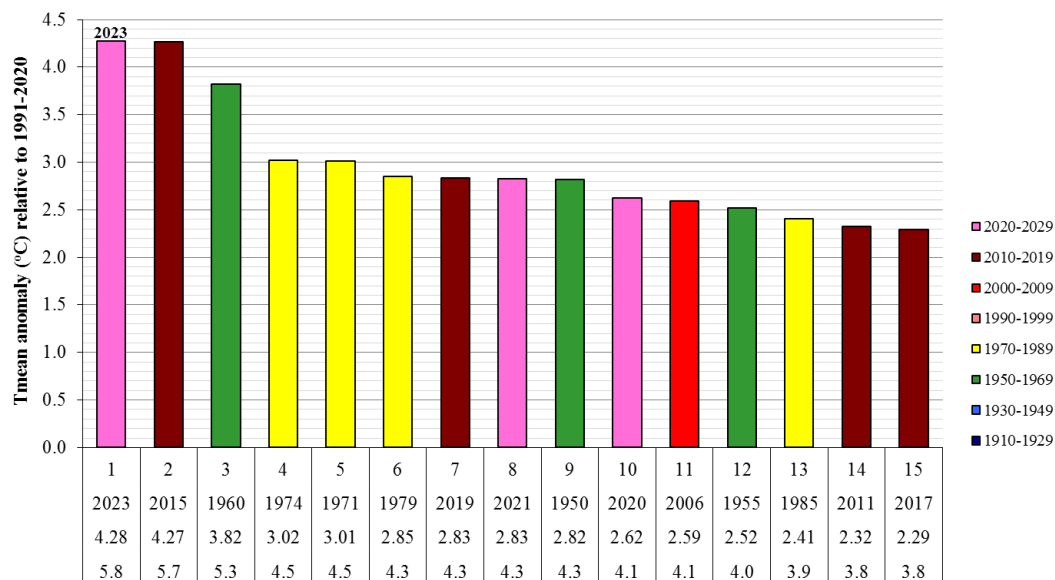
At the beginning of the third decade, a spatial upper-air depression and strong northwesterly circulation were established over northern and central Europe. Consequently, most pronounced was impact of a cold front from the northwest, followed by a series of waves of moist air within the aforementioned west-northwest upper-air circulation. The weather remained predominantly cloudy, with occasional rain and snow on the mountains, more precipitation was observed in the central and southern regions. From the middle of the third decade, there was a significant increase in geopotential, the advection of warm air masses from the south, and a weakly pronounced predominantly zonal upper-air circulation, resulting in mainly dry and extremely warm weather.

* National Center for Hydrometeorological Early Warning System

APPENDIX

Ranks of the warmest December

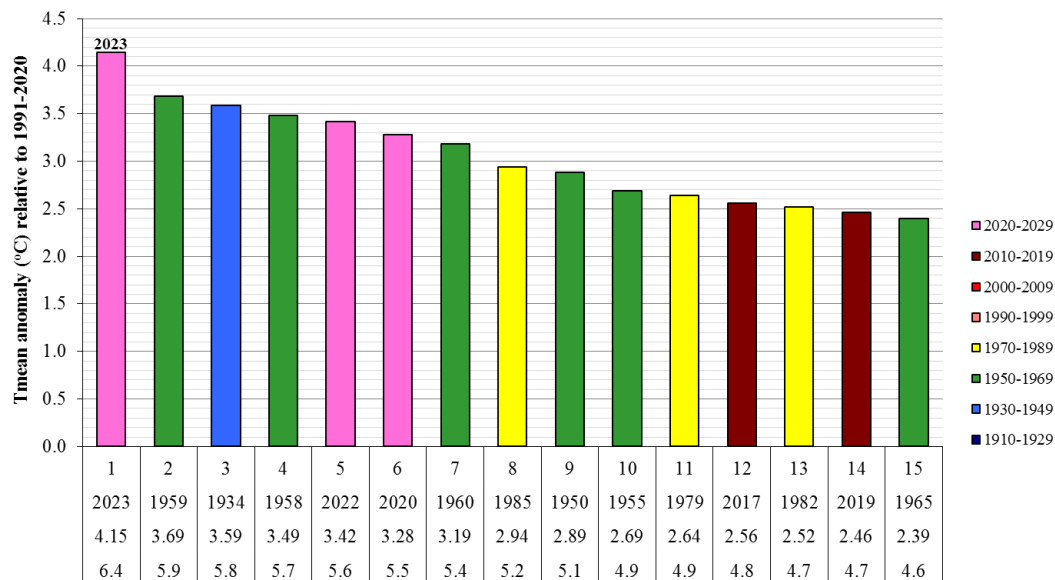
Anomaly of mean December temperature relative to 1991-2020 base period
Negotin - 1927-2023 period



ranking - year - Tmean anomaly (°C) relative to 1991-2020 - Tmean

Appendix 1. Rank of the warmest December in Negotin

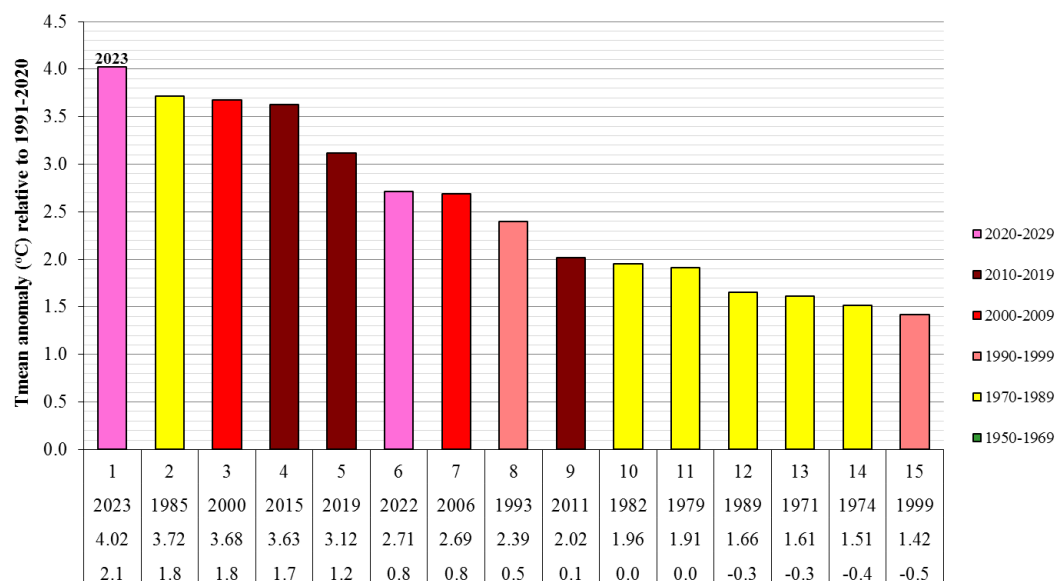
Anomaly of mean December temperature relative to 1991-2020 base period
Valjevo - 1926-2023 period



ranking - year - Tmean anomaly (°C) relative to 1991-2020 - Tmean

Appendix 2. Rank of the warmest December in Valjevo

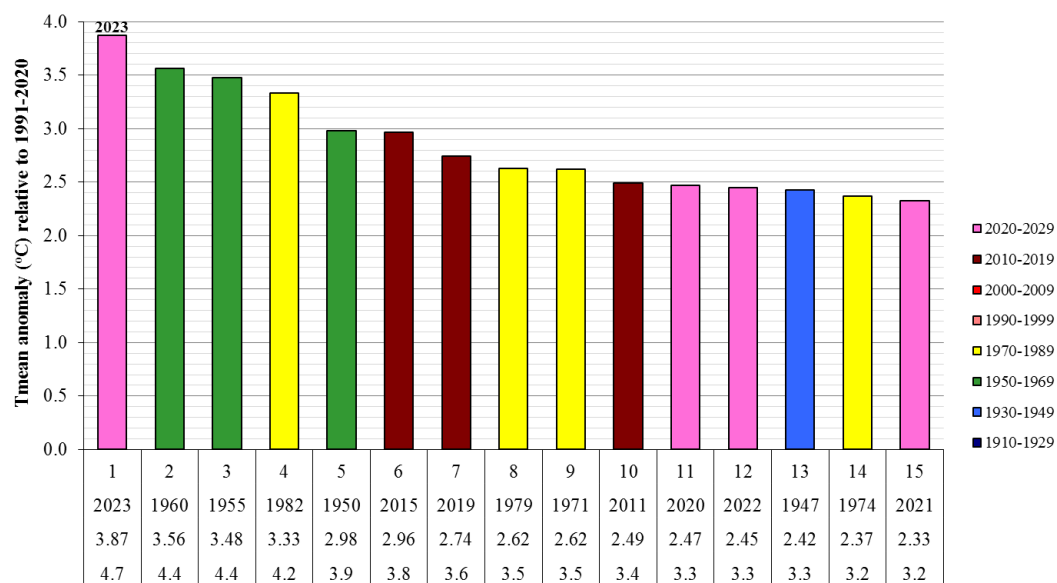
**Anomaly of mean December temperature relative to 1991-2020 base period
Crni Vrh - 1966-2023 period**



ranking - year - Tmean anomaly (°C) relative to 1991-2020 - Tmean

Appendix 3. Rank of the warmest December on Crni Vrh

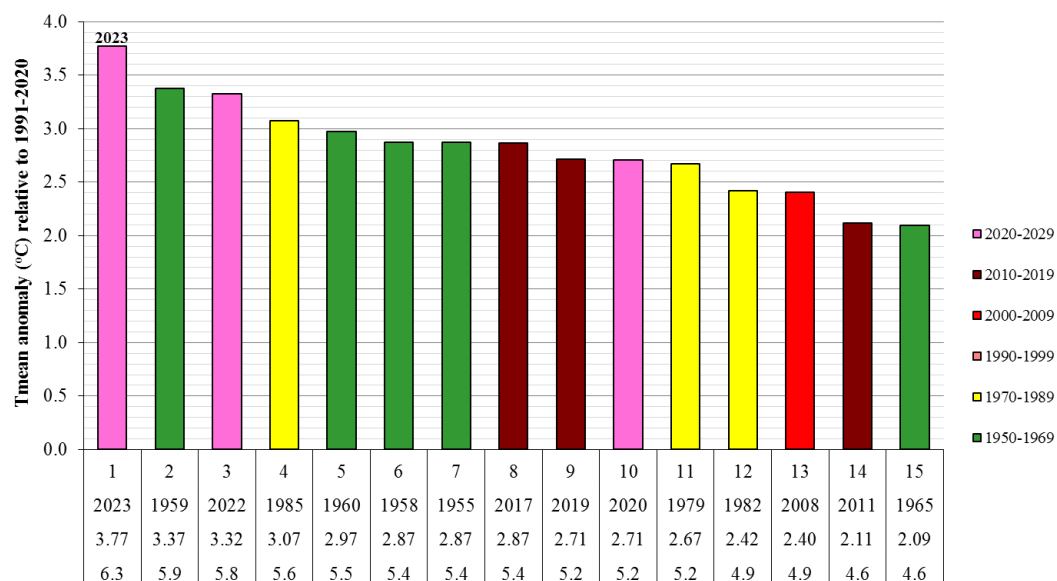
**Anomaly of mean December temperature relative to 1991-2020 base period
Zajecar - 1929-2023 period**



ranking - year - Tmean anomaly (°C) relative to 1991-2020 - Tmean

Appendix 4. Rank of the warmest December in Zajecar

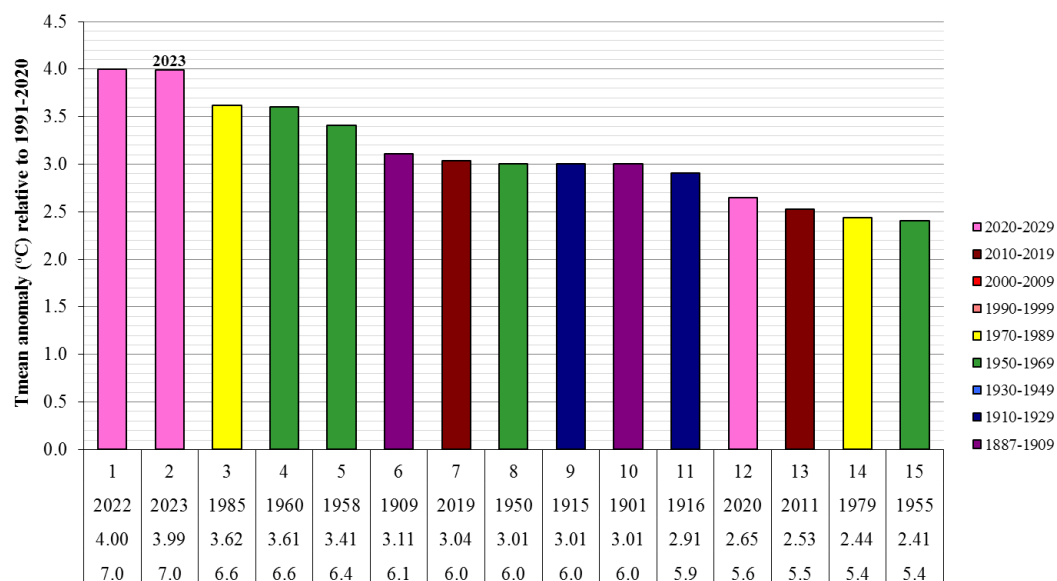
**Anomaly of mean December temperature relative to 1991-2020 base period
Loznica - 1952-2023 period**



ranking - year - Tmean anomaly (°C) relative to 1991-2020 - Tmean

Appendix 5. Rank of the warmest December in Loznica

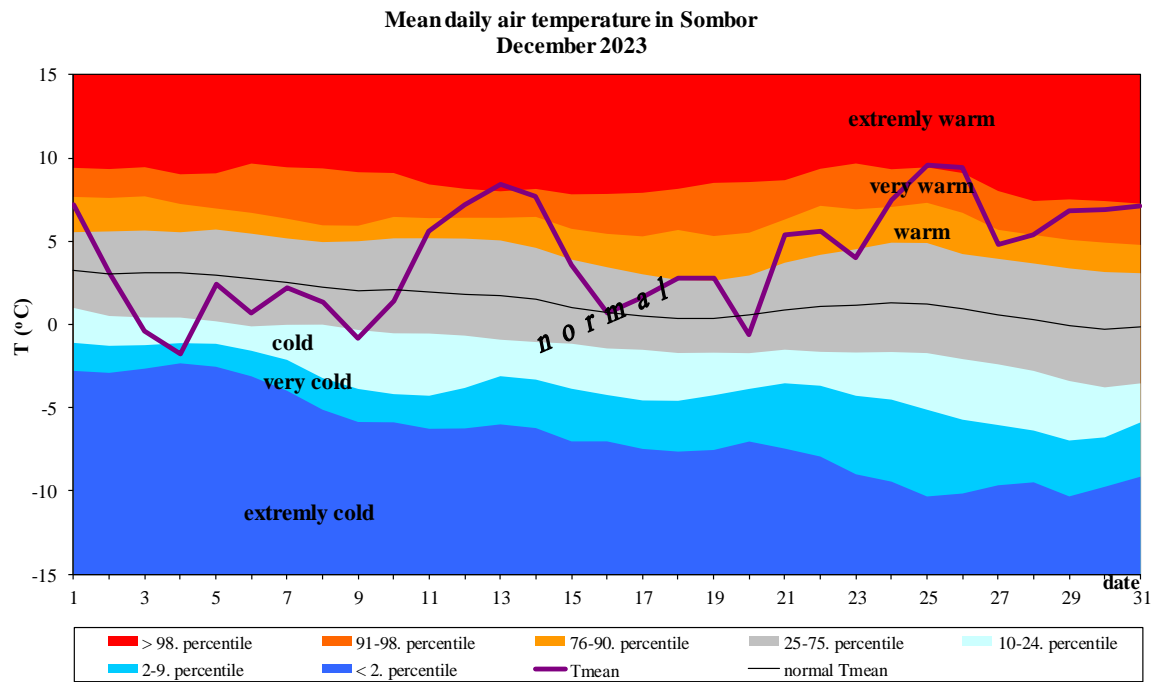
**Anomaly of mean December temperature relative to 1991-2020 base period
Belgrade - 1887-2023 period**



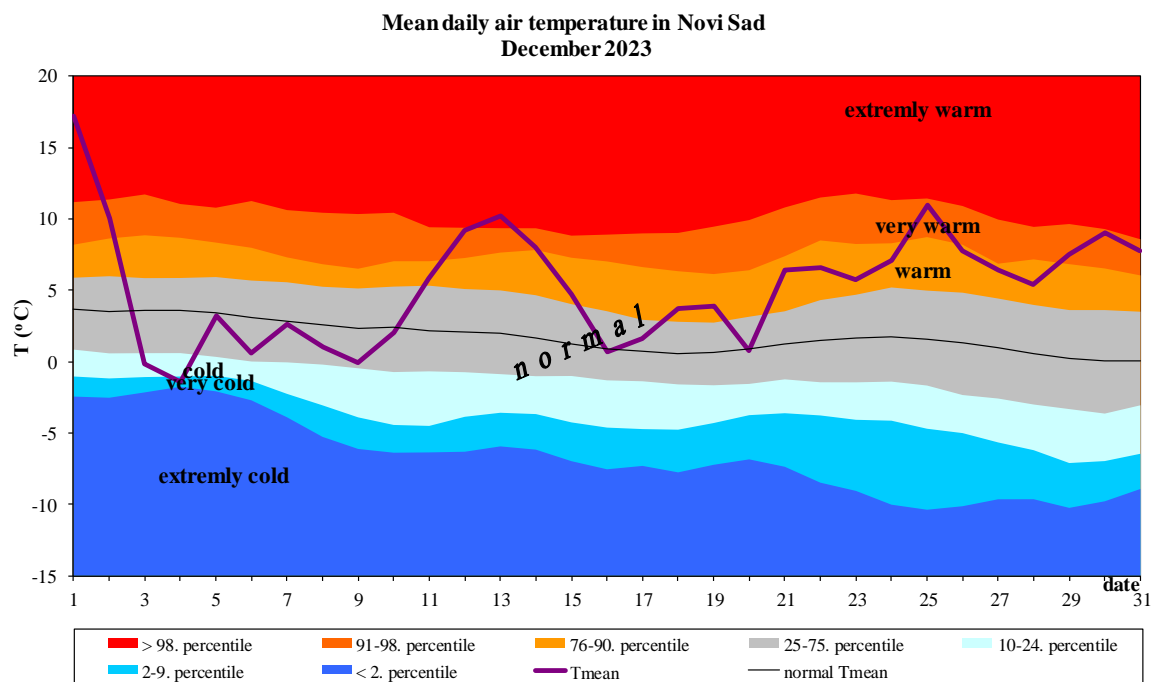
ranking - year - Tmean anomaly (°C) relative to 1991-2020 - Tmean

Appendix 6. Rank of the warmest December in Belgrade

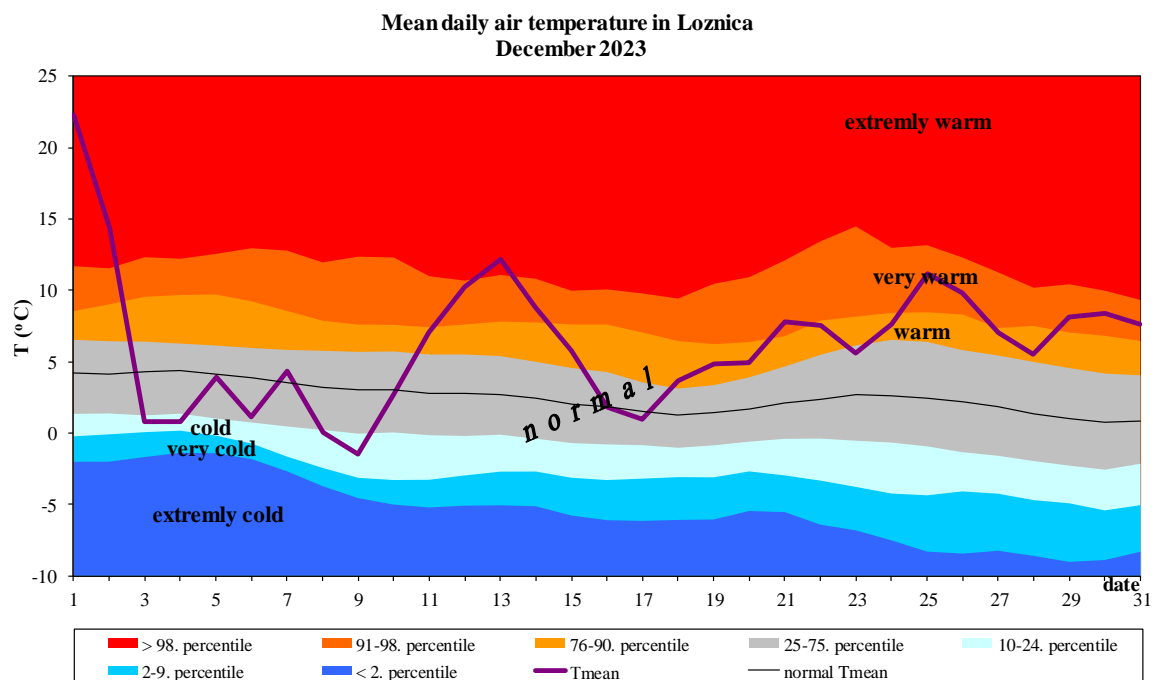
Mean air temperature



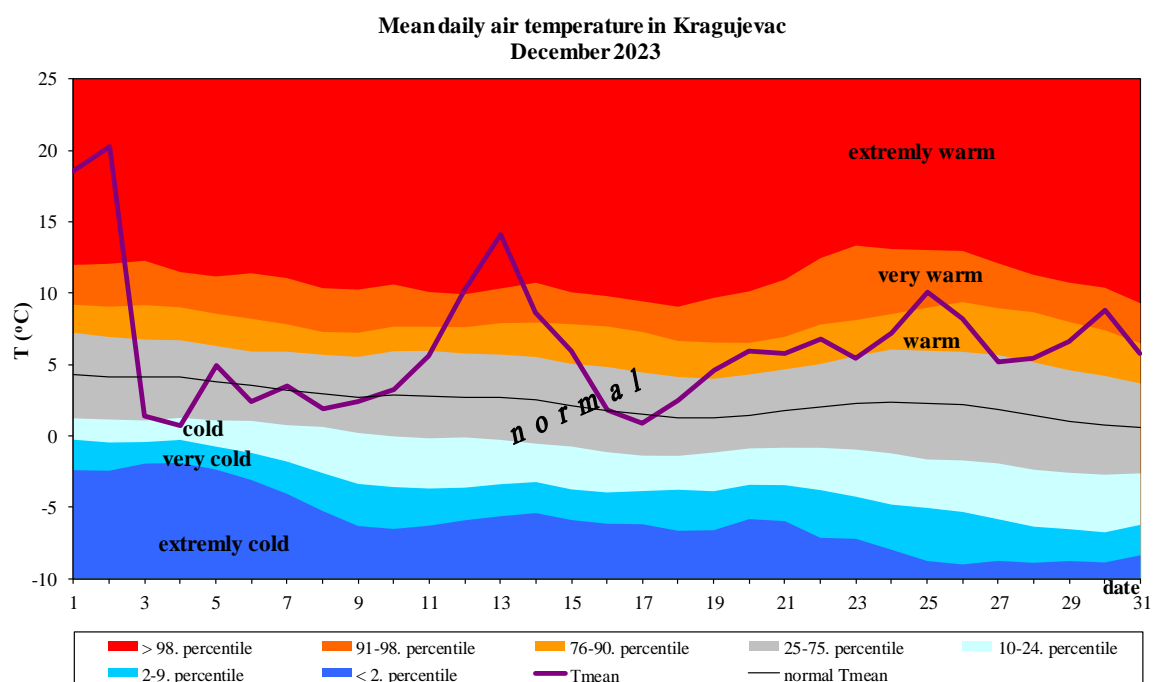
Appendix 7. Daily course of the mean daily air temperature and accompanying percentile for Sombor



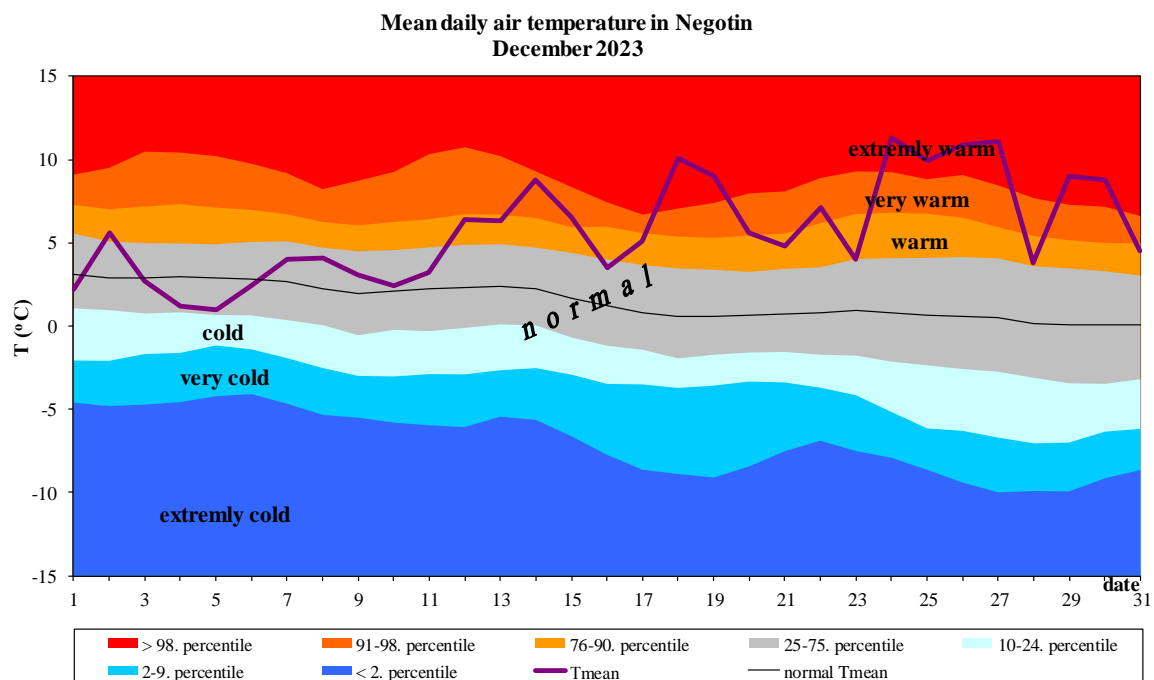
Appendix 8. Daily course of the mean daily air temperature and accompanying percentile for Novi Sad



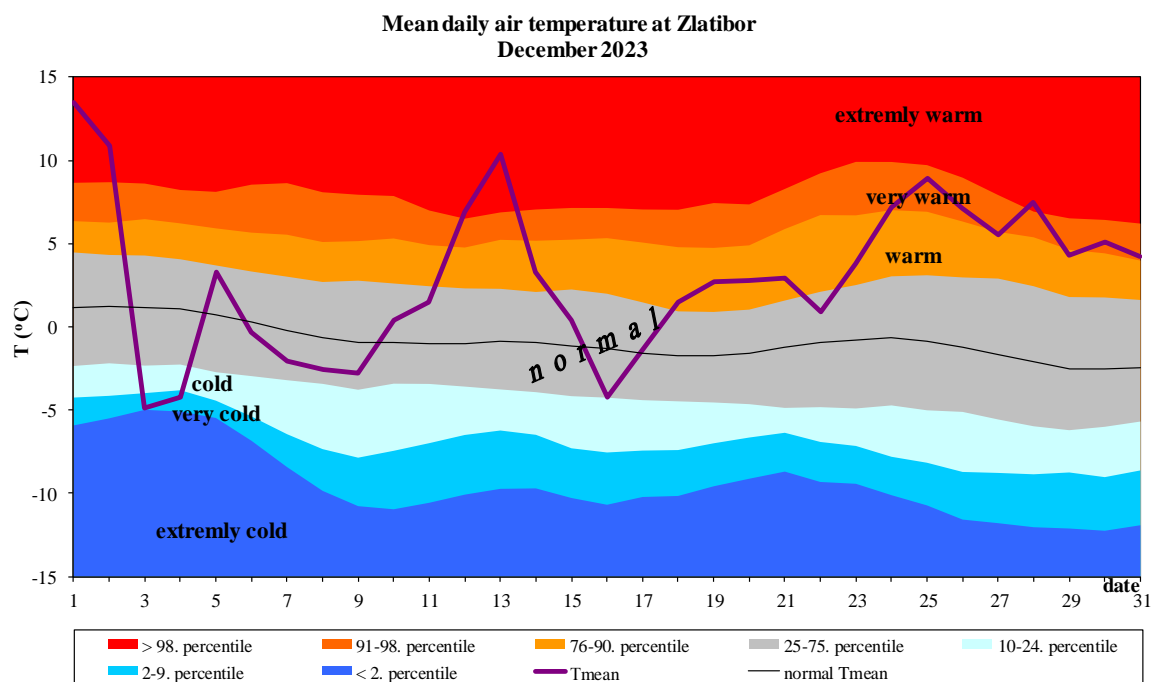
Appendix 9. Daily course of the mean daily air temperature and accompanying percentile for Loznica



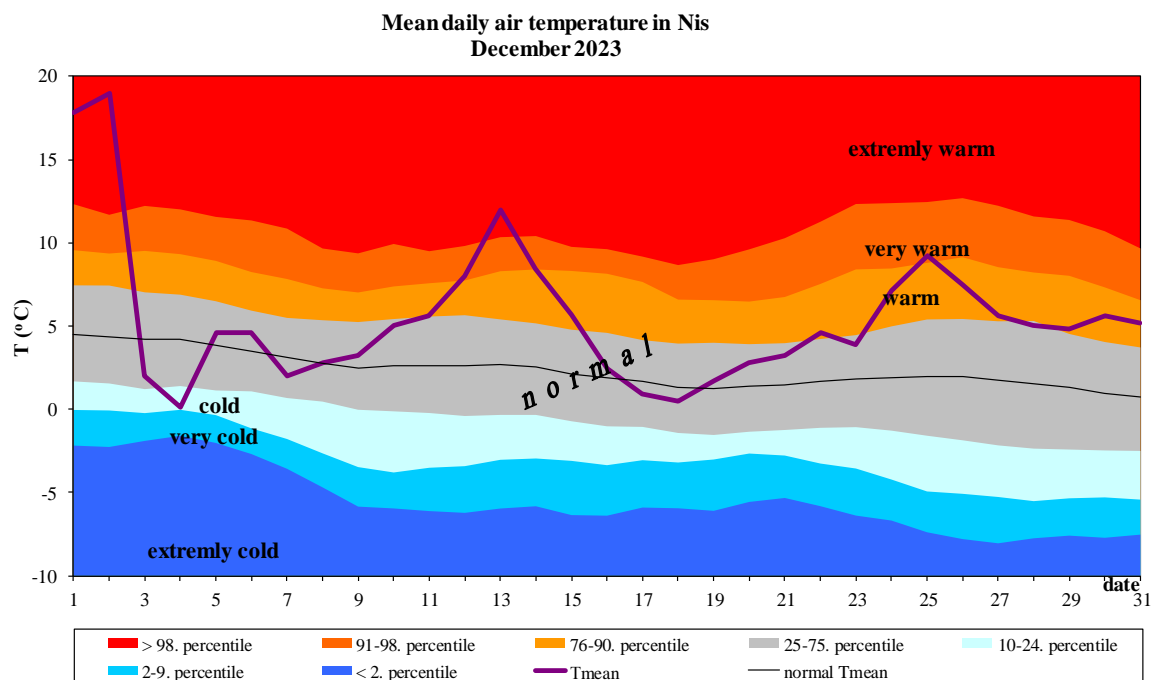
Appendix 10. Daily course of the mean daily air temperature and accompanying percentile for Kragujevac



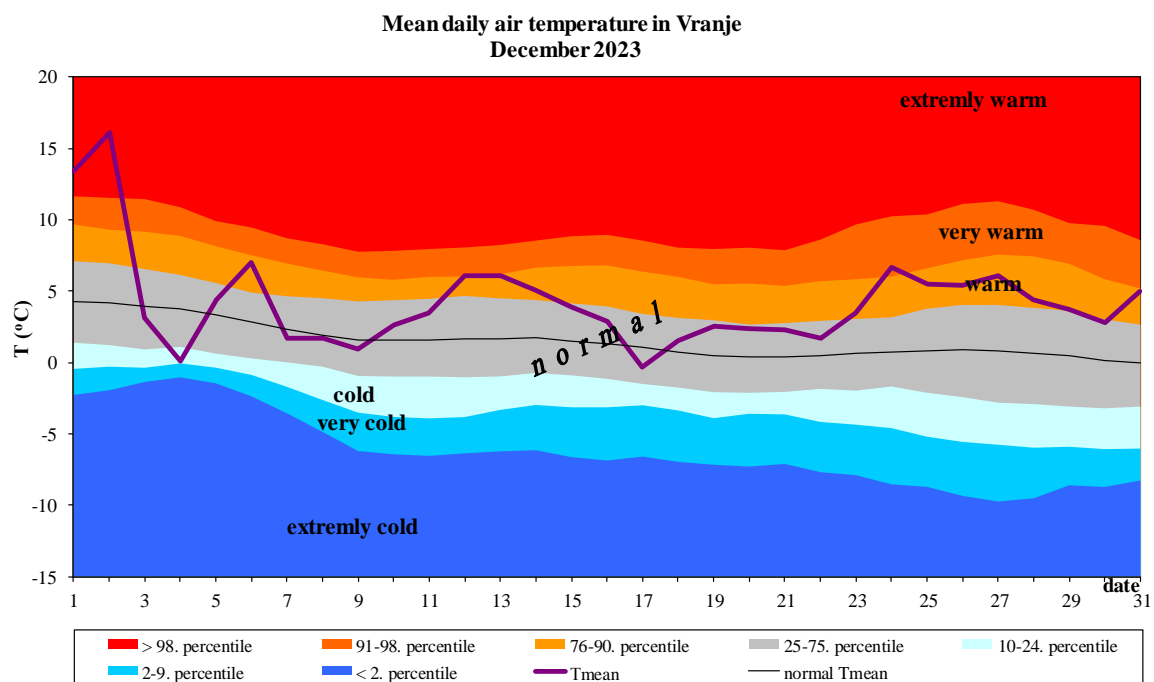
Appendix 11. Daily course of the mean daily air temperature and accompanying percentile for Negotin



Appendix 12. Daily course of the mean daily air temperature and accompanying percentile on Zlatiboru

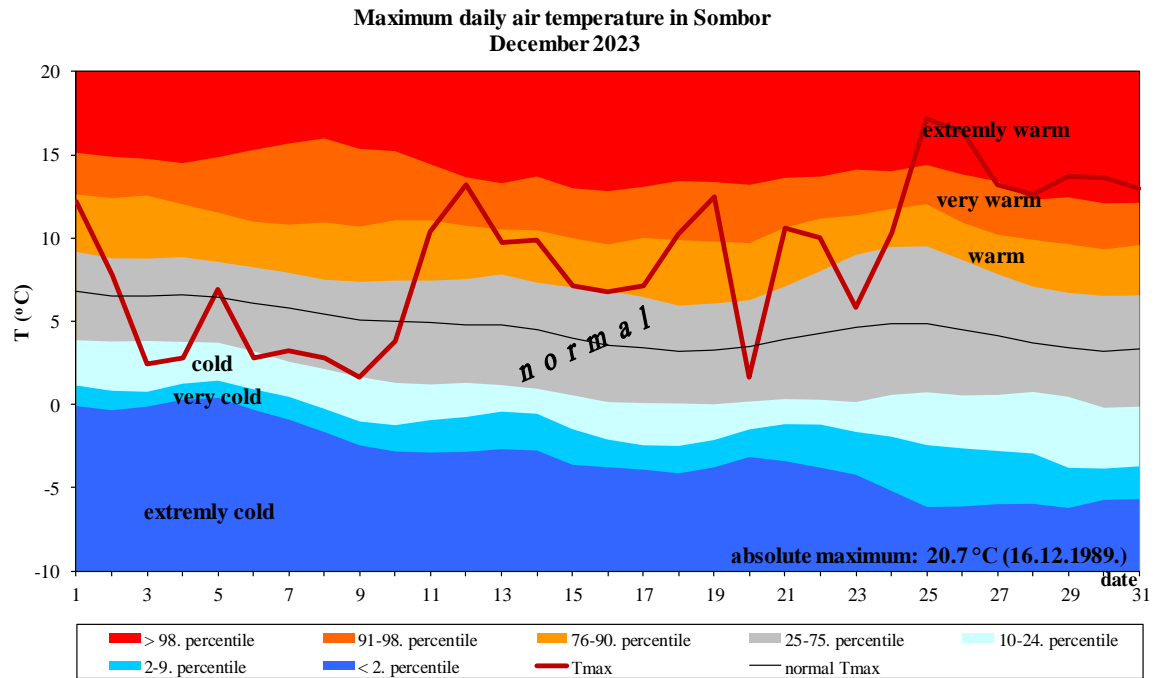


Appendix 13. Daily course of the mean daily air temperature and accompanying percentile for Nis

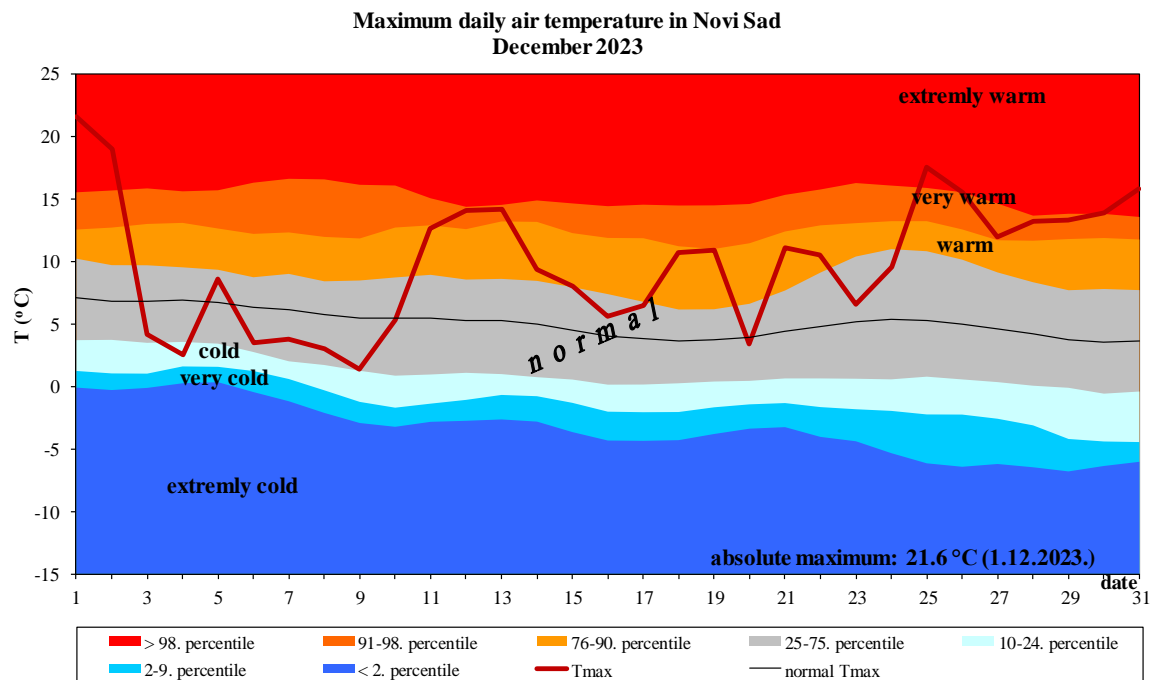


Appendix 14. Daily course of the mean daily air temperature and accompanying percentile for Vranje

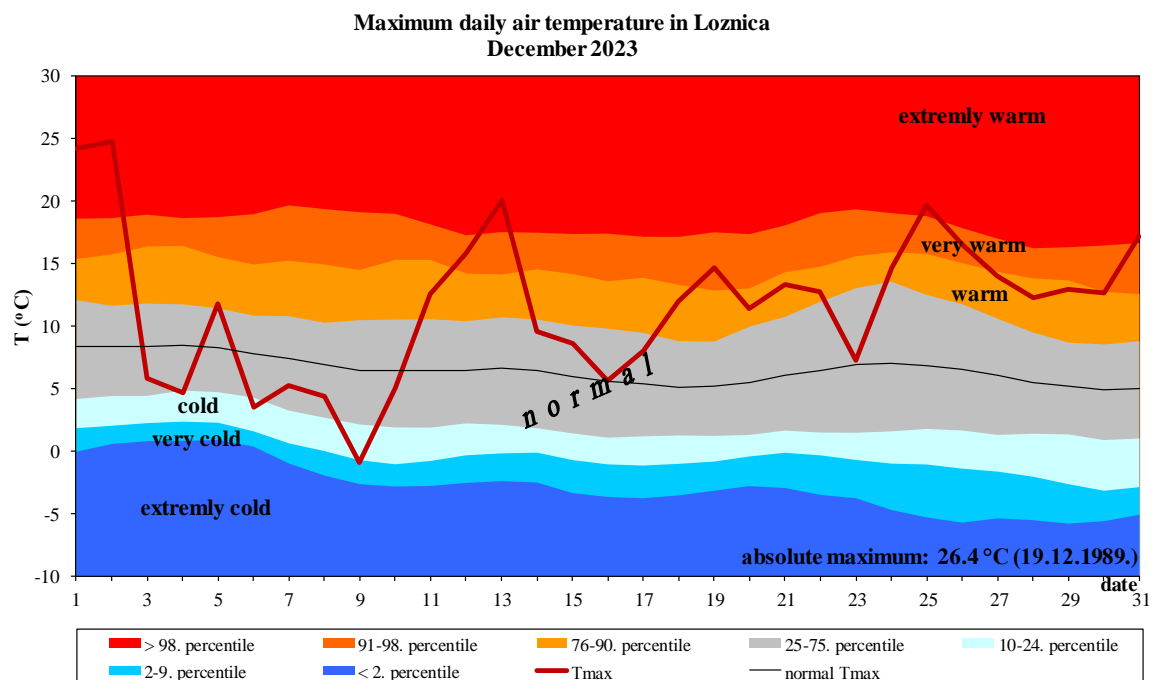
Maximum air temperature



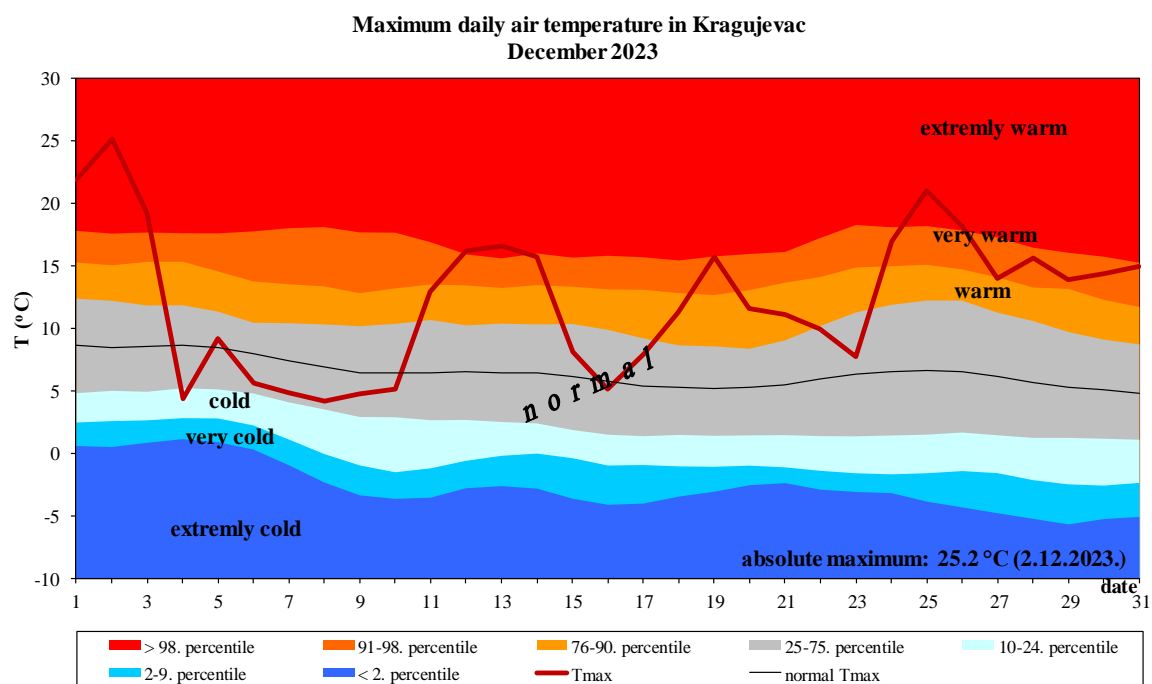
Appendix 15. Daily course of the maximum daily air temperature and the accompanying percentile for Sombor



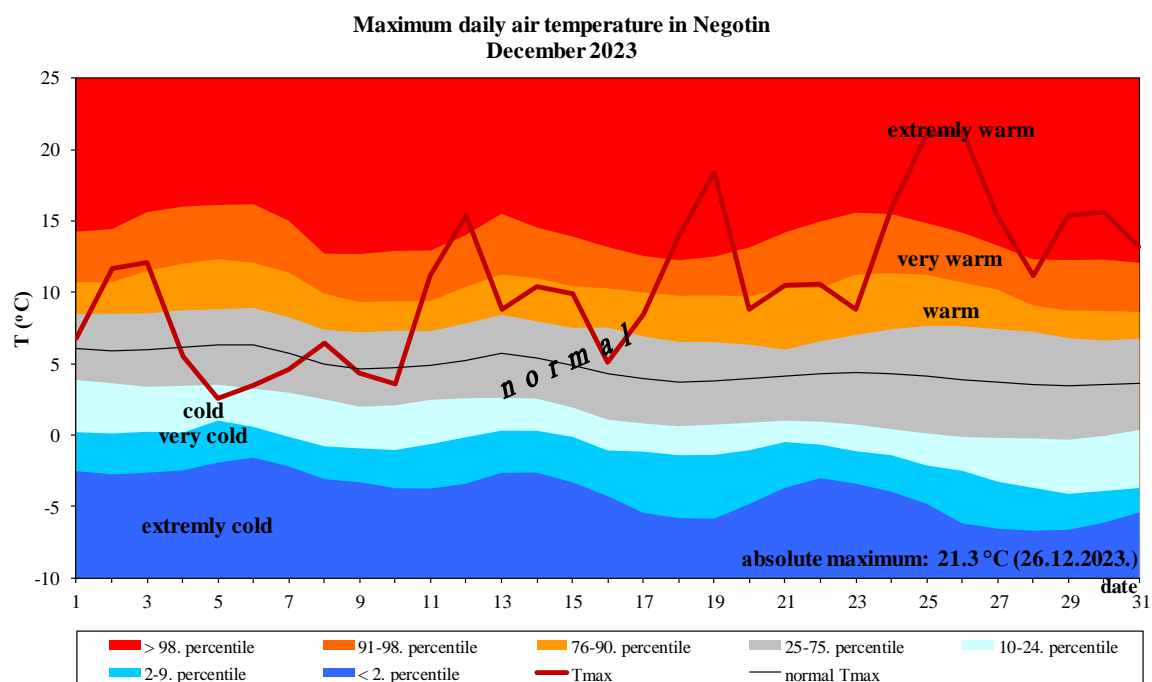
Appendix 16. Daily course of the maximum daily air temperature and the accompanying percentile for Novi Sad



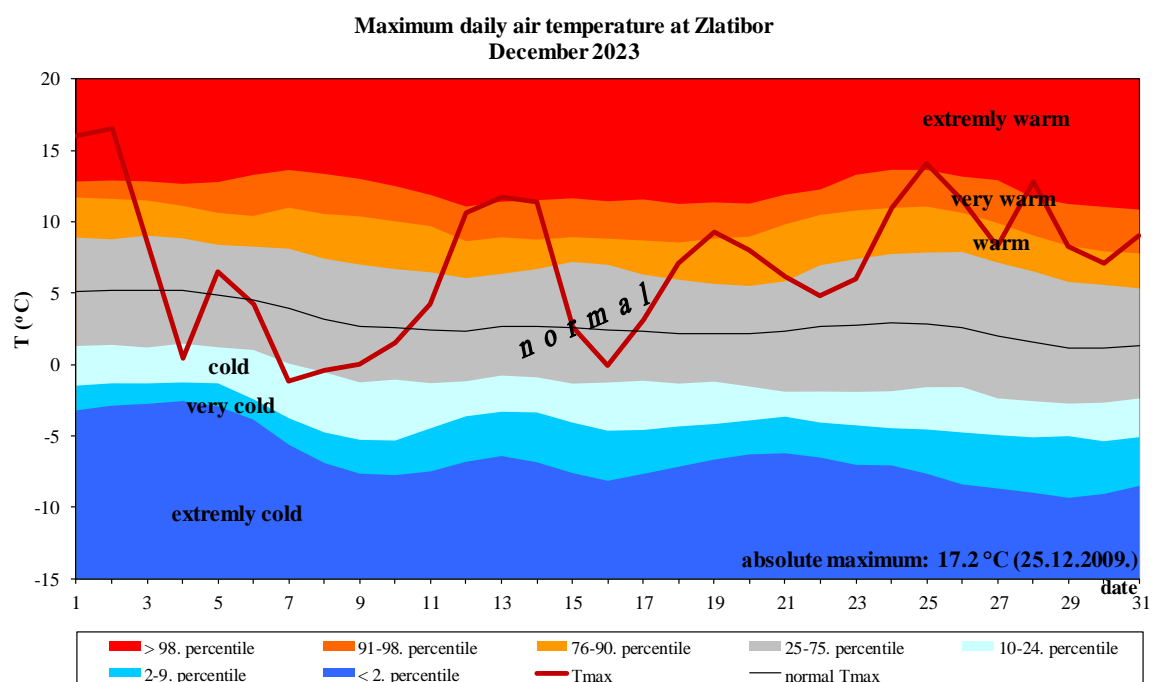
Appendix 17. Daily course of the maximum daily air temperature and the accompanying percentile for Loznica



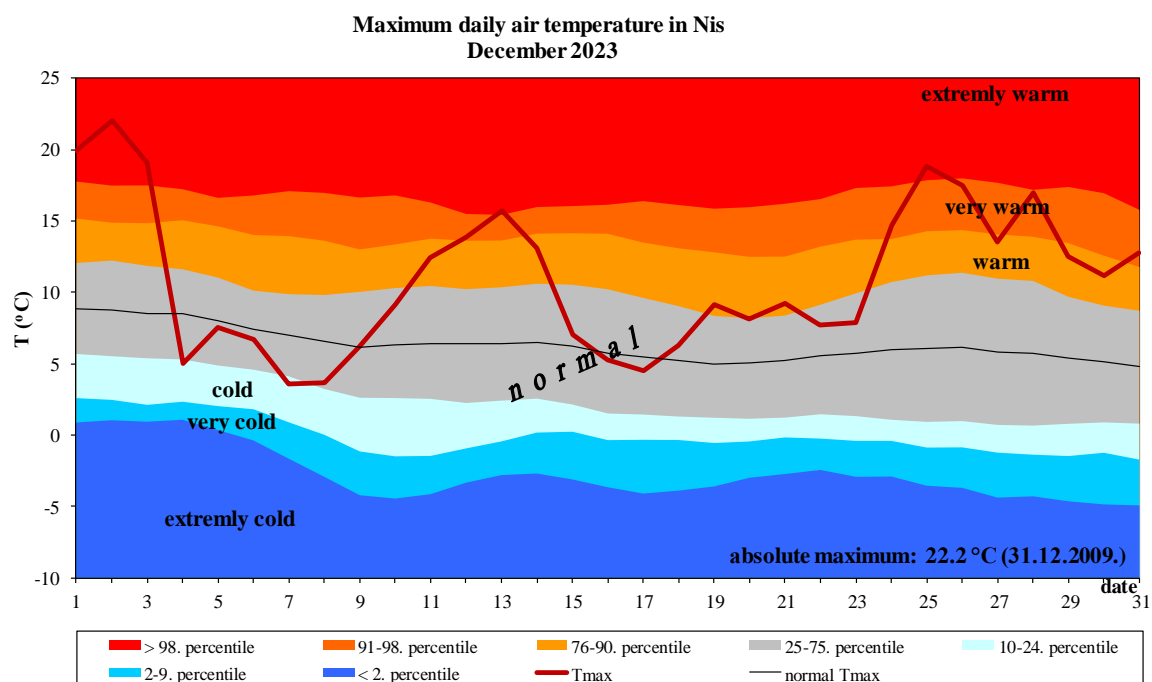
Appendix 18. Daily course of the maximum daily air temperature and the accompanying percentile for Kragujevac



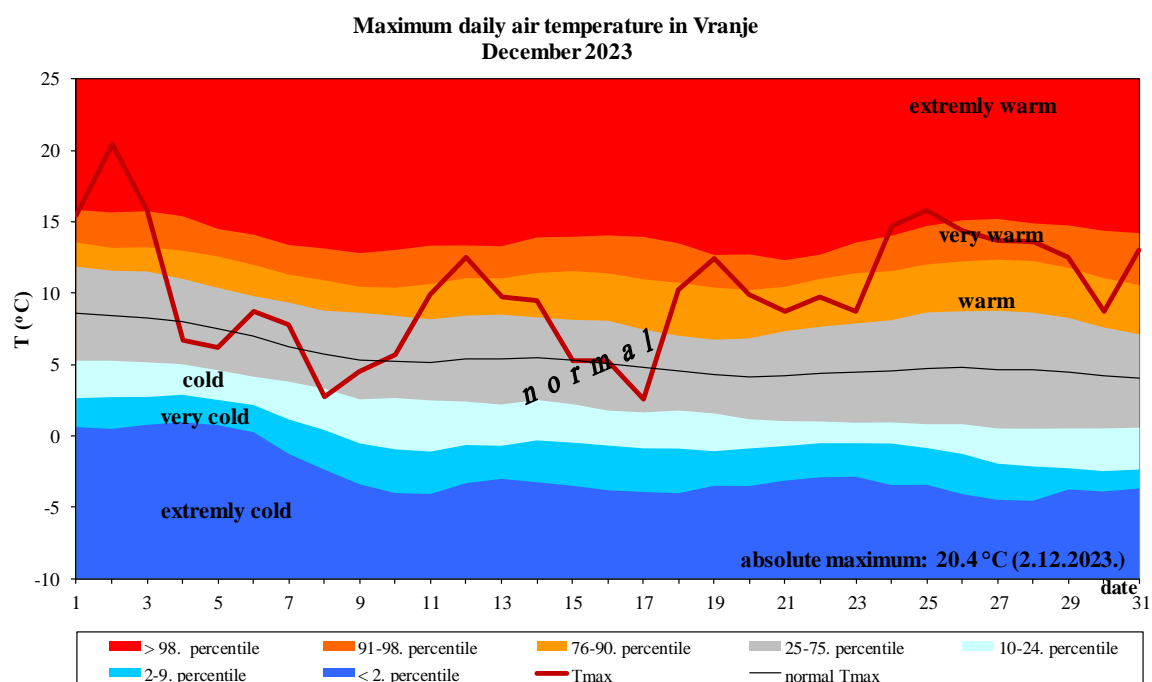
Appendix 19. Daily course of the maximum daily air temperature and the accompanying percentile for Negotin



Appendix 20. Daily course of the maximum daily air temperature and the accompanying percentile on Zlatibor

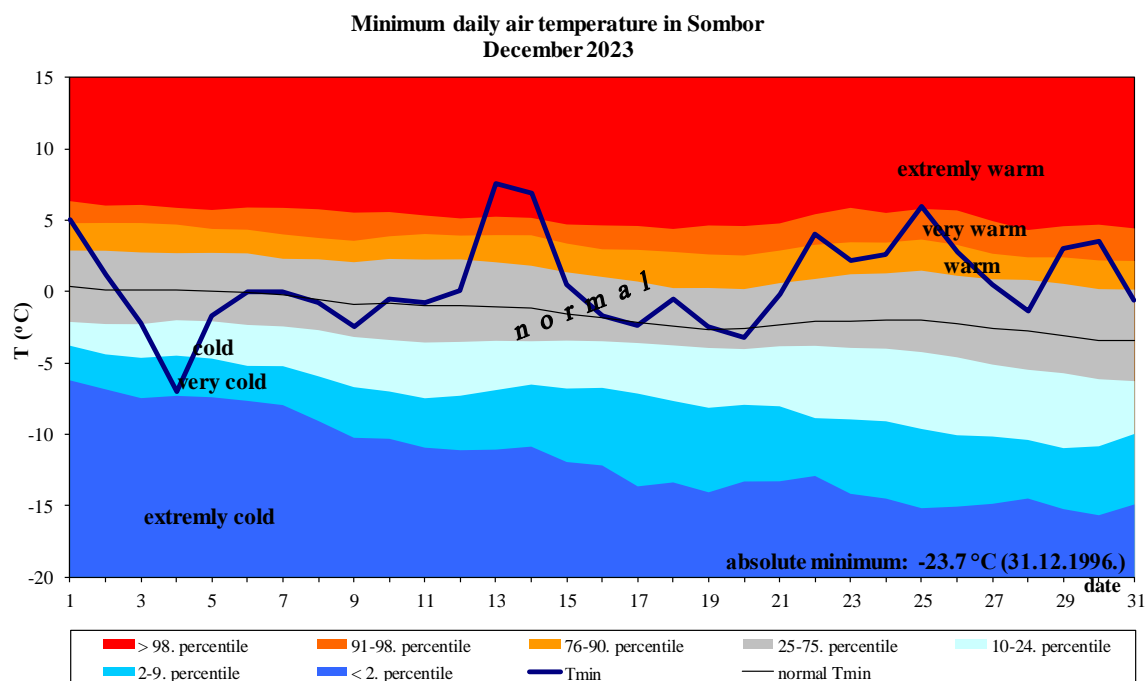


Appendix 21. Daily course of the maximum daily air temperature and the accompanying percentile for Nis

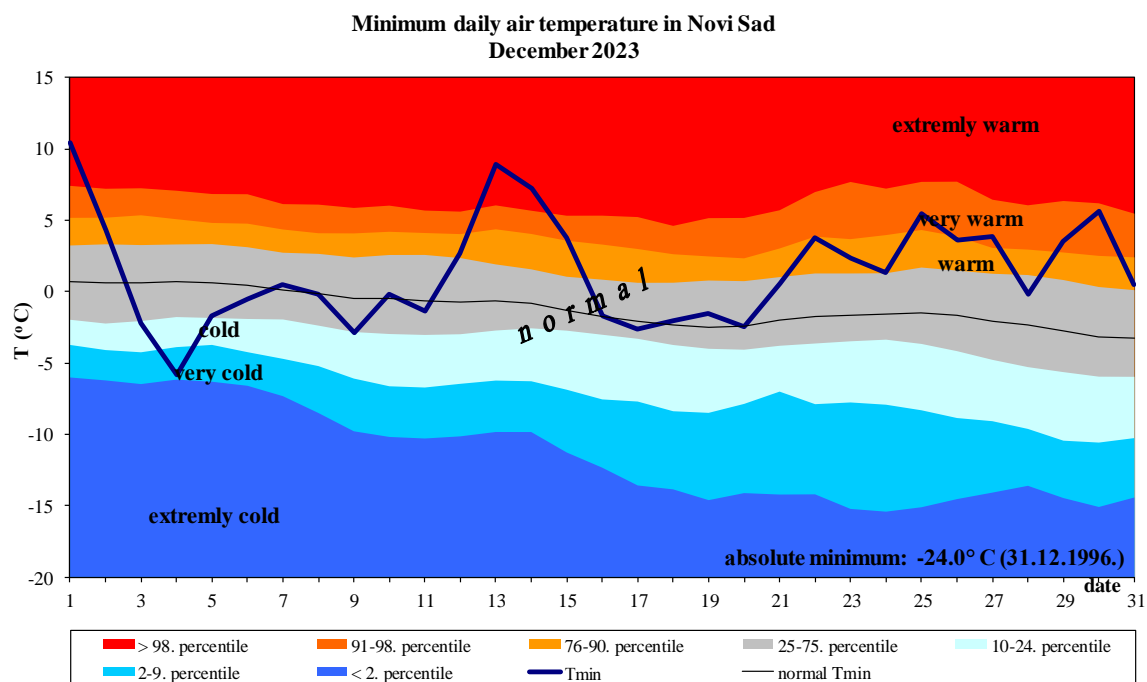


Appendix 22. Daily course of the maximum daily air temperature and the accompanying percentile for Vranje

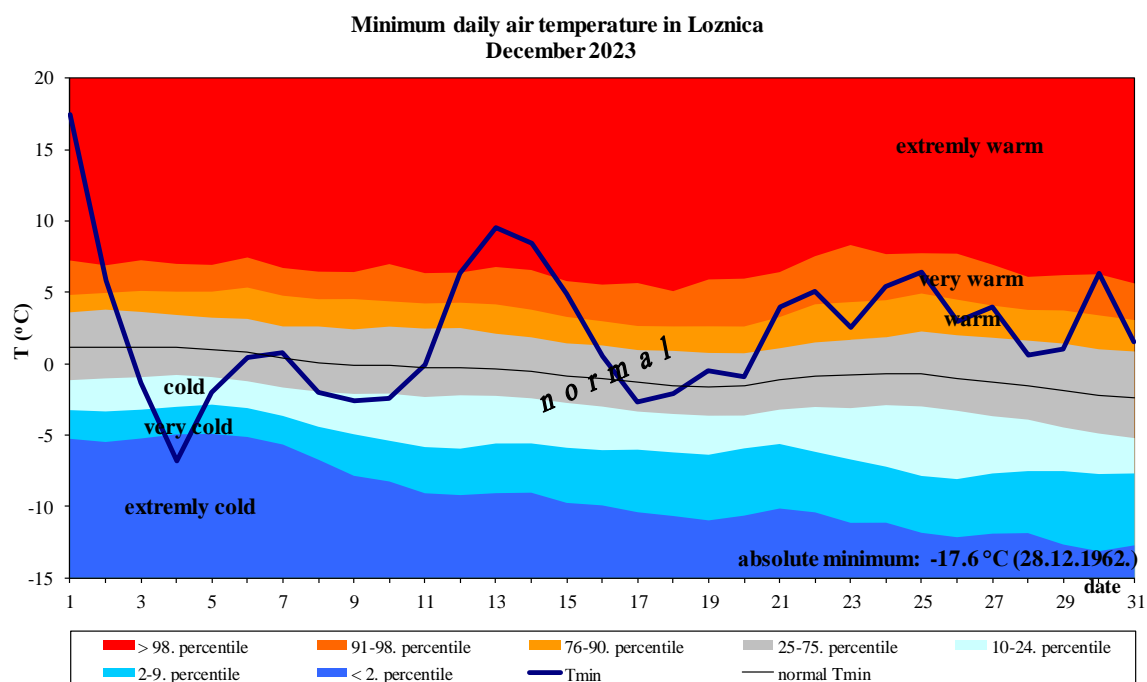
Minimum air temperature



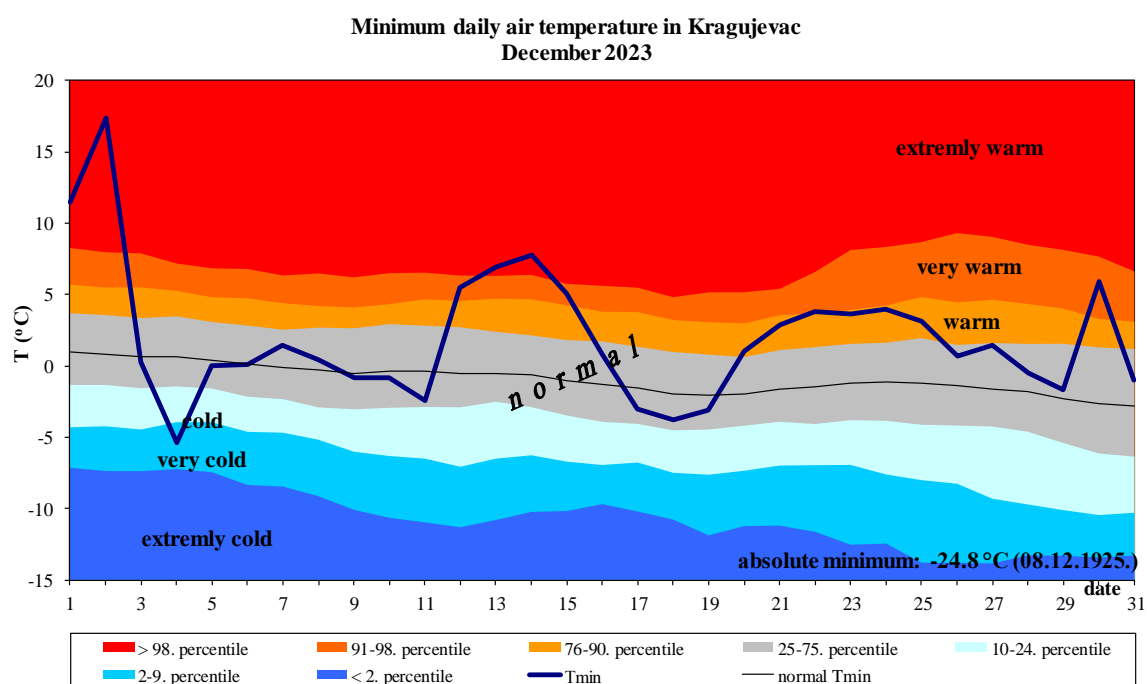
Appendix 23. Daily course of the minimum daily air temperature and the accompanying percentile for Sombor



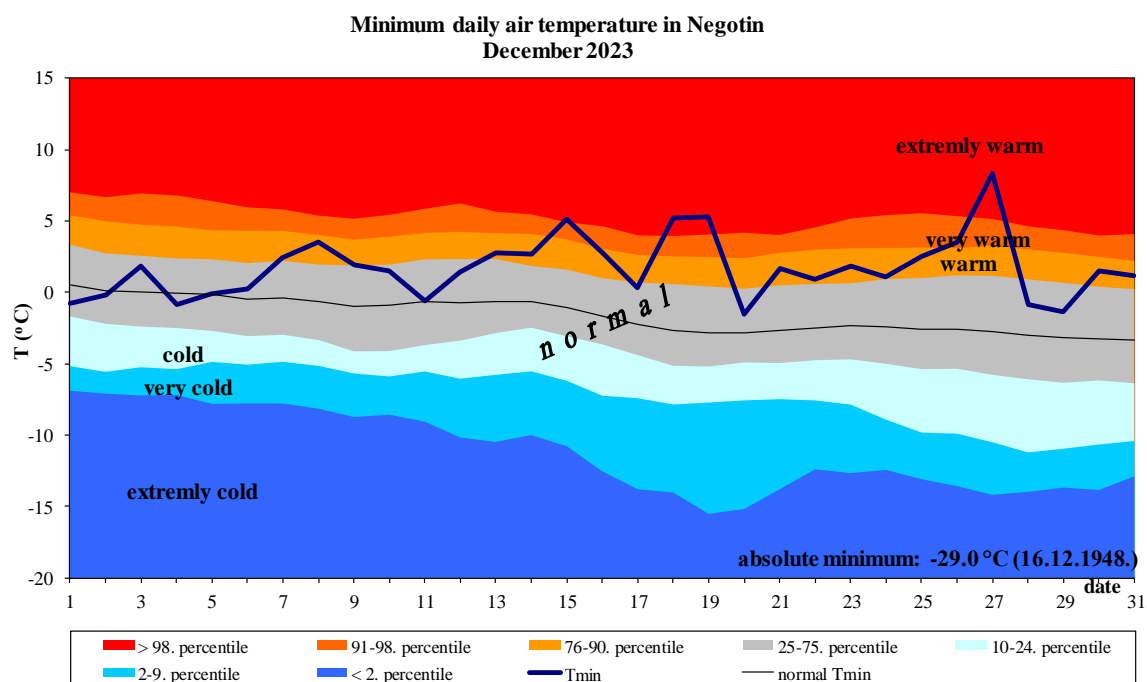
Appendix 24. Daily course of the minimum daily air temperature and the accompanying percentile for Novi Sad



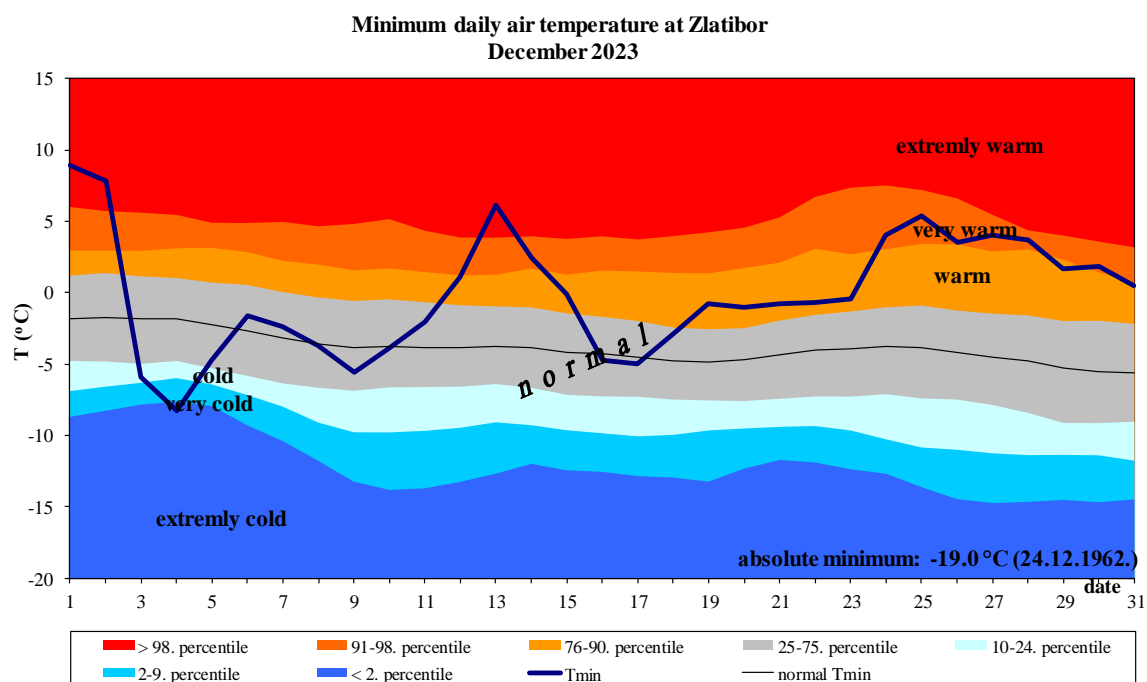
Appendix 25. Daily course of the minimum daily air temperature and the accompanying percentile for Loznica



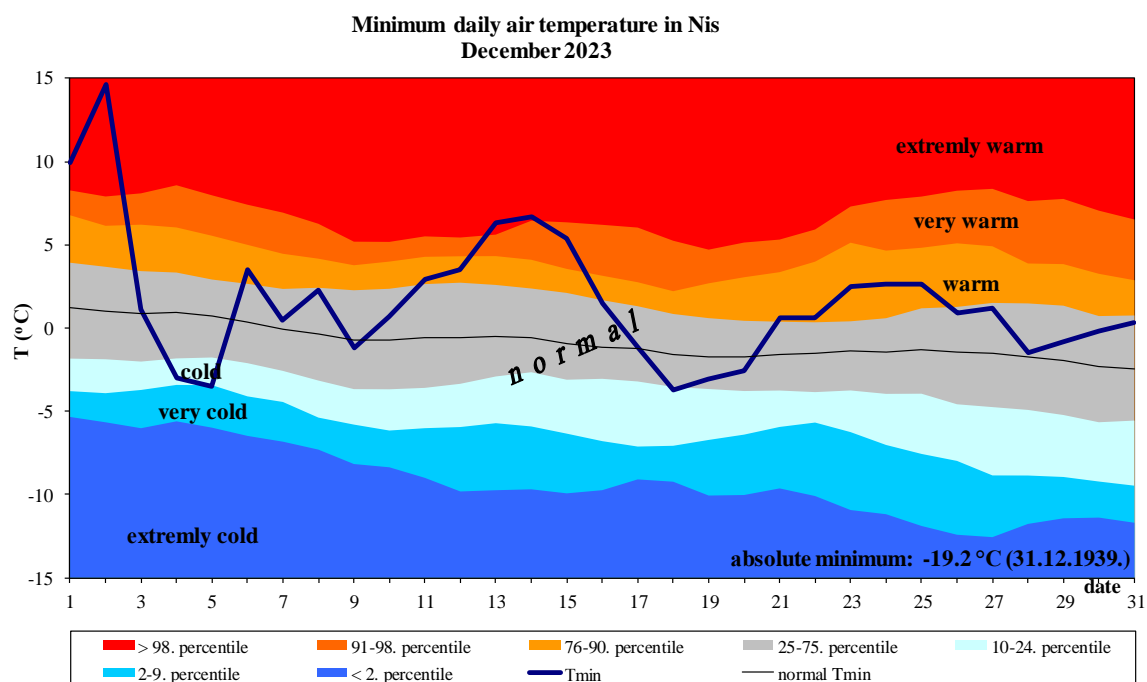
Appendix 26. Daily course of the minimum daily air temperature and the accompanying percentile for Kragujevac



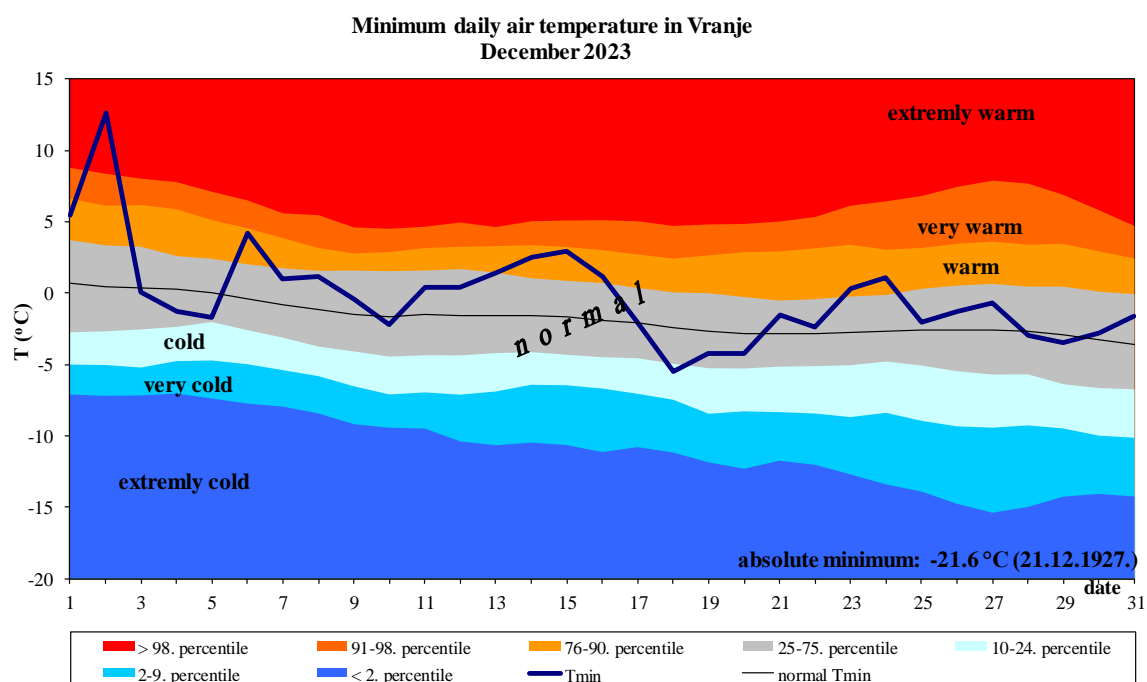
Appendix 27. Daily course of the minimum daily air temperature and the accompanying percentile for Negotin



Appendix 28. Daily course of the minimum daily air temperature and the accompanying percentile on Zlatibor

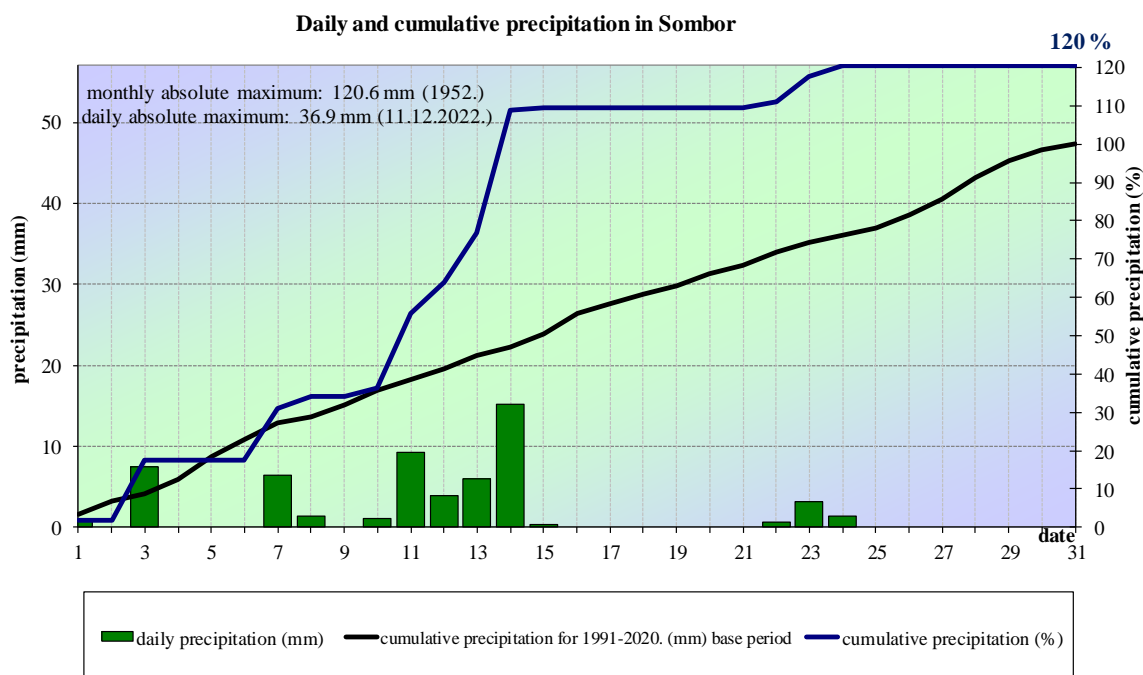


Appendix 29. Daily course of the minimum daily air temperature and the accompanying percentile for Nis

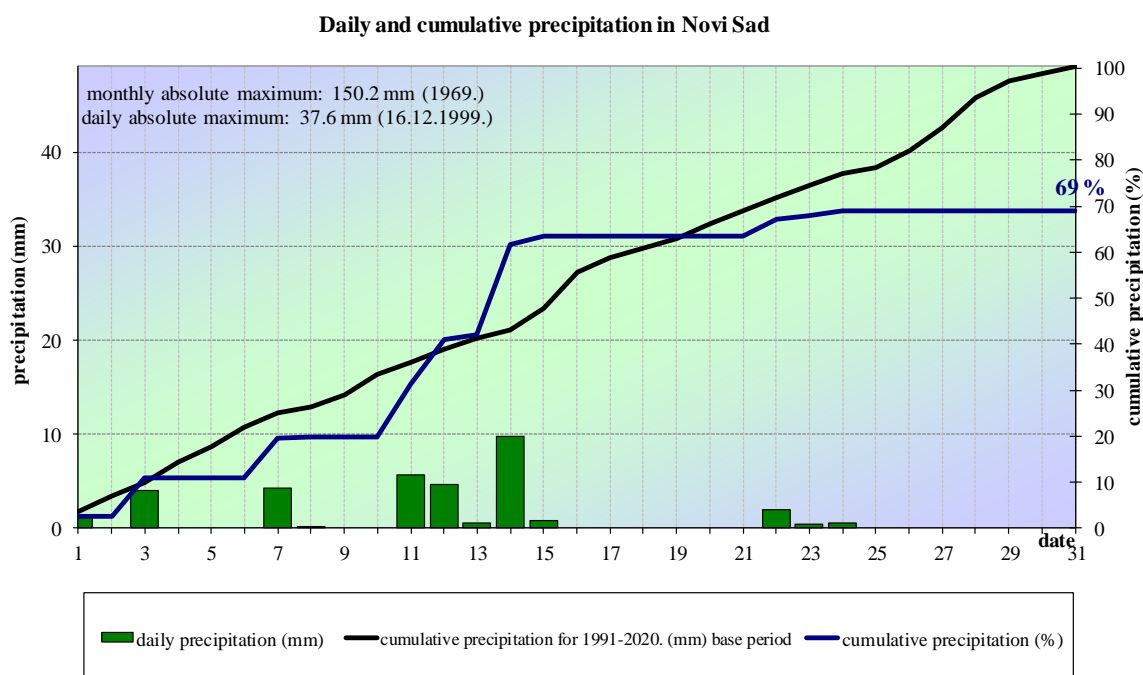


Appendix 30. Daily course of the minimum daily air temperature and the accompanying percentile for Vranje

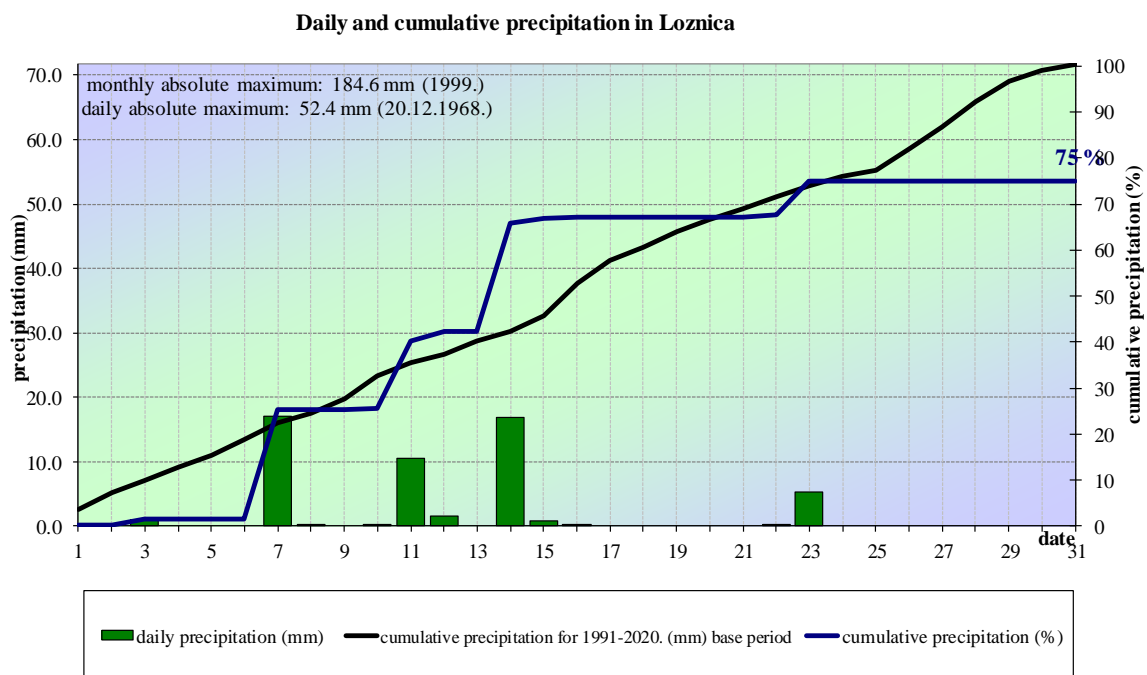
Precipitation



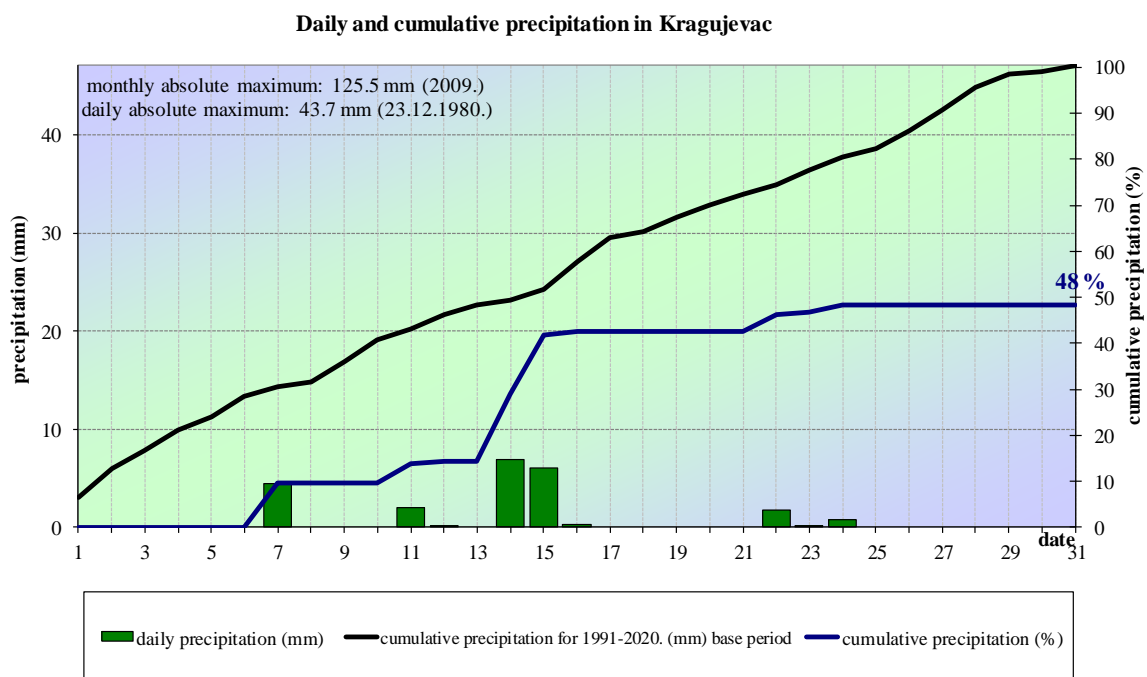
Appendix 31. Daily and cumulative precipitation sums for Sombor



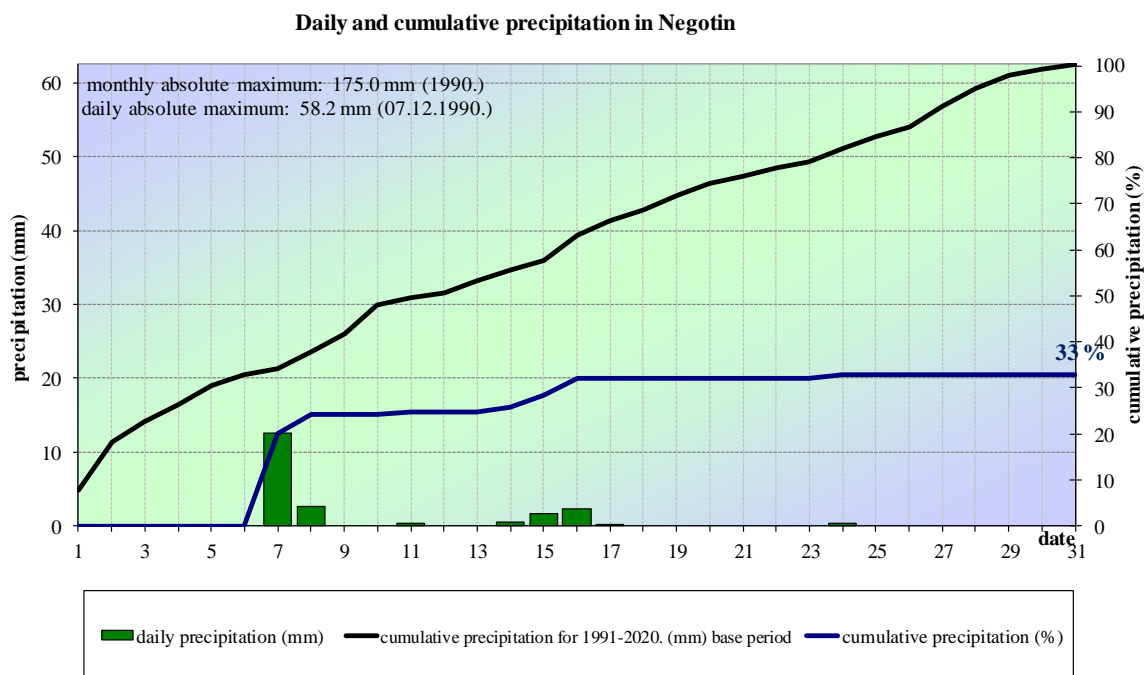
Appendix 32. Daily and cumulative precipitation sums for Novi Sad



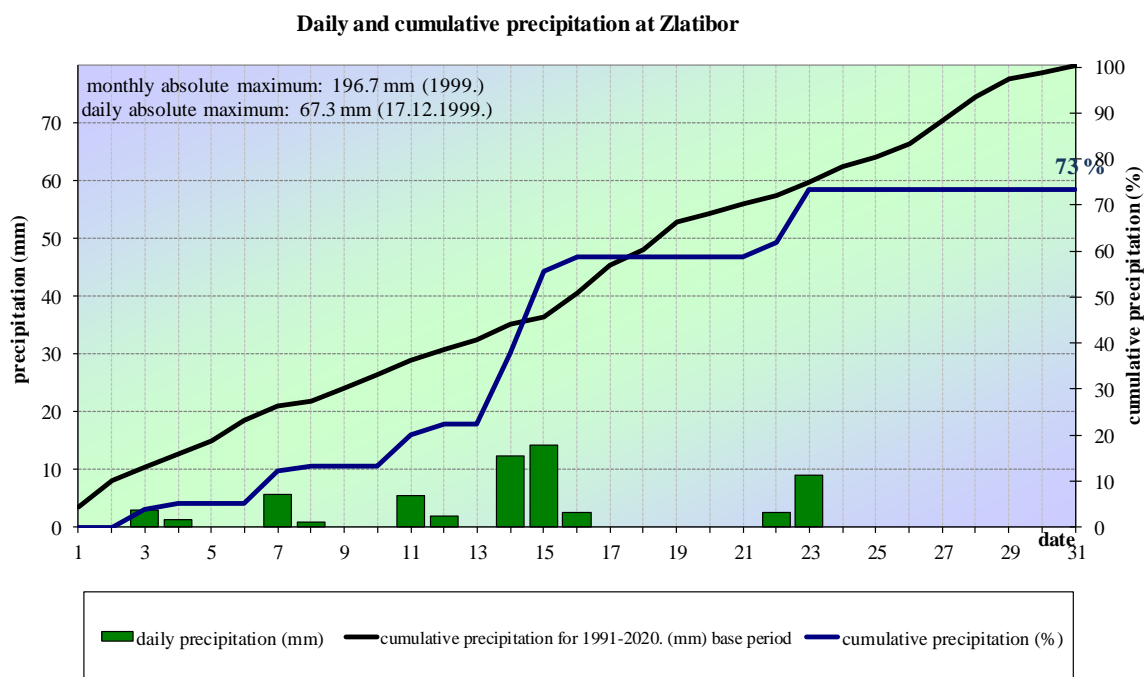
Appendix 33. Daily and cumulative precipitation sums for Loznica



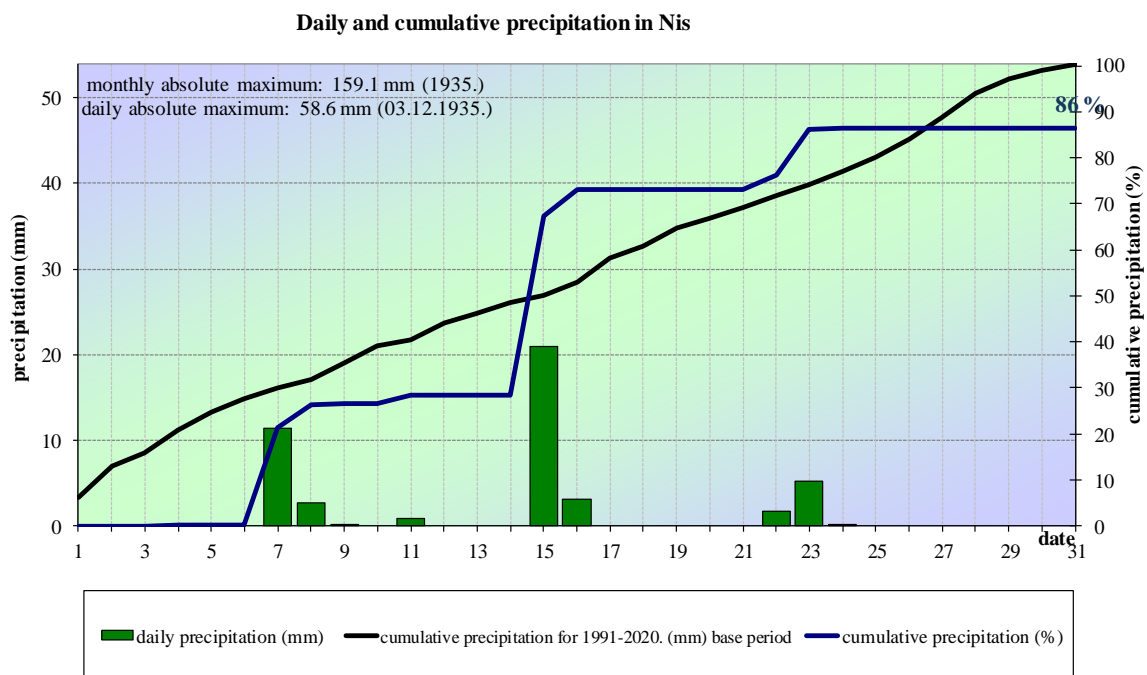
Appendix 34. Daily and cumulative precipitation sums for Kragujevac



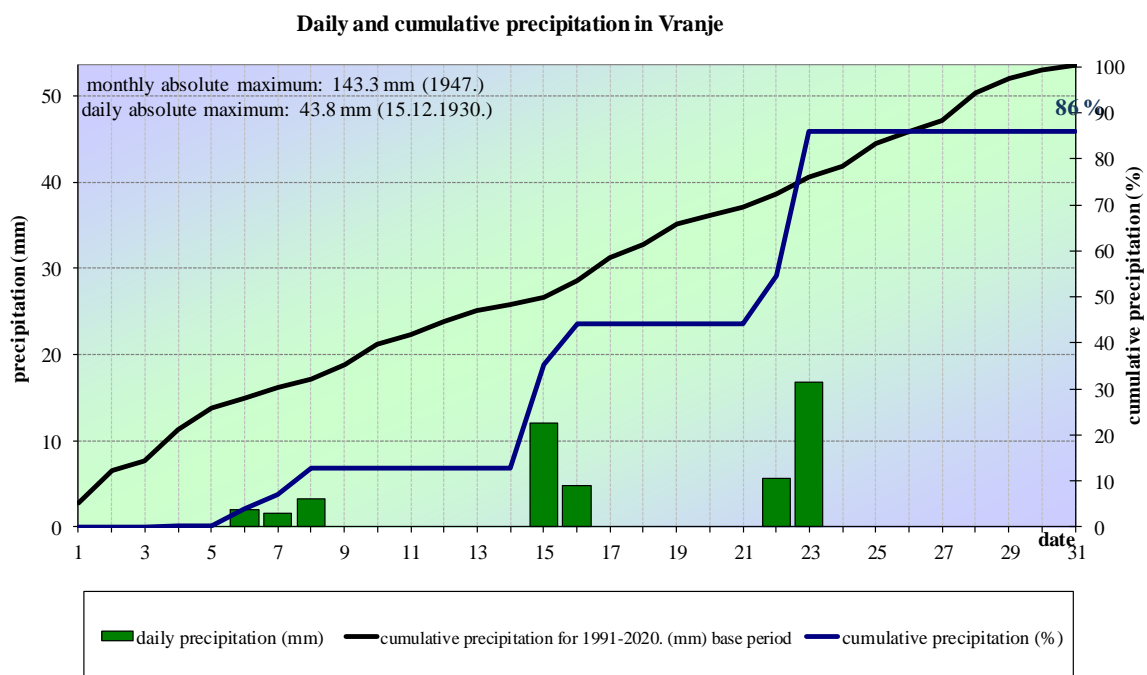
Appendix 35. Daily and cumulative precipitation sums for Negotin



Appendix 36. Daily and cumulative precipitation sums on Zlatibor



Appendix 37. Daily and cumulative precipitation sums for Nis



Appendix 38. Daily and cumulative precipitation sums for Vranje