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

MONTHLY BULLETIN FOR SERBIA

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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

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AIR TEMPERATURE

Mean monthly air temperature

June 2024 was **the warmest** for Serbia since 1951 with the mean air temperature of **22,8°C** for the 1951-2024 period and anomaly of **+3°C** compared to the 1991-2020 average (*Figure 1).* Since the record-keeping began, June 2024 ranks as the warmest on record or 2nd warmest at nearly all main meteorological stations, apart from Sombor, where it was 4th warmest (*Table 1).*

In appendix are graphs depicting 15 warmest years since the measurements for the stations began: Crni Vrh, Kopaonik, Dimitrovgrad, Novi Sad, Vranje, Belgrade, Nis, Kragujevac and Sjenica.

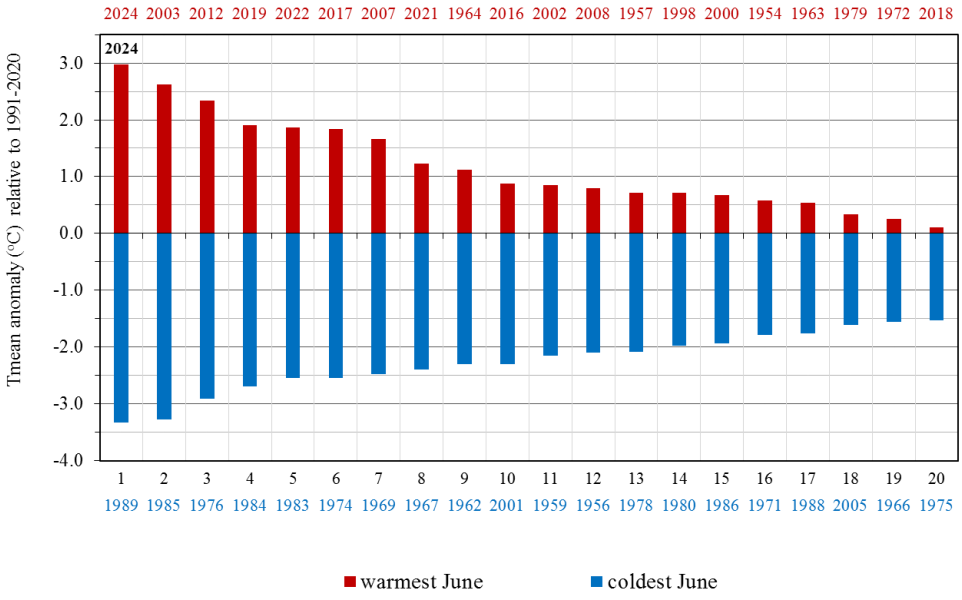


Figure 1. Rank of the warmest and coldest June in Serbia for the period from 1951 to 2024

Table 1. Ranking of June 2024 with mean air temperature, average and departure from the normal 1991-2020

STATION	historical period	Tmean (°C) - June 2024	1991-2020 base period for June	temperature anomaly (°C)	ranking for June 2024
CRNI VRH	1966-2023	19.3	15.4	3.9	1
KOPAONIK	1950-2023	15.1	11.3	3.8	1
DIMITROVGRAD	1945-2023	22.5	18.7	3.7	1
KURSUMLIJA	1952-2023	22.5	18.9	3.6	1
NOVI SAD	1948-2023	24.3	20.9	3.5	1
CUPRIJA	1948-2023	24.1	20.5	3.5	1
VRANJE	1926-2023	23.5	20.1	3.5	1
BEOGRAD	1888-2023	25.2	21.9	3.3	1
NIS	1925-2023	24.3	21.1	3.2	1
LESKOVAC	1948-2023	23.5	20.4	3.1	1
KRAGUJEVAC	1925-2023	23.8	20.7	3.0	1
KRALJEVO	1926-2023	23.5	20.5	3.0	1
S.PALANKA	1939-2023	23.9	20.9	3.0	1
SJENICA	1946-2023	18.3	15.3	3.0	1
KRUSEVAC	1927-2023	23.6	20.7	2.9	1
B.KARLOVAC	1986-2023	23.7	20.9	2.7	1
POZEGA	1952-2023	21.6	19.0	2.6	1
NEGOTIN	1927-2023	25.3	22.2	3.1	2
ZLATIBOR	1950-2023	19.3	16.2	3.0	2
ZRENJANIN	1946-2023	24.1	21.2	2.9	2
VALJEVO	1926-2023	23.7	20.8	2.9	2
KIKINDA	1948-2023	23.9	21.2	2.8	2
V.GRADISTE	1926-2023	23.5	20.8	2.8	2
PALIC	1945-2023	23.8	21.2	2.6	2
LOZNICA	1952-2023	23.4	20.9	2.5	2
S.MITROVICA	1925-2023	23.1	20.7	2.4	2
ZAJECAR	1929-2023	23.2	20.9	2.3	2
SOMBOR	1942-2023	23.2	20.9	2.3	4

Mean June air temperature ranged from 21,6ºC in Pozega to 25,3ºC in Negotin. Belgrade observed mean air temperature of 25,2ºC, whereas on the mountains, air temperature was in a range from 15,1ºC at Kopaonik to 19,3ºC at Crni Vrh and Zlatibor (*Figure 2*).

Departure of the mean monthly air temperature from the normal[1] for the 1991–2020 ranged from +2,3ºC in Sombor and Zajecar to +3,9ºC at Crni Vrh (*Figure 3*).

Mean air temperature, based on the percentile method[2], was in the category of extremely warm in most of country, very warm on Palic, Sombor, Loznica and Sremska Mitrovica (*Figure 4).*

[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

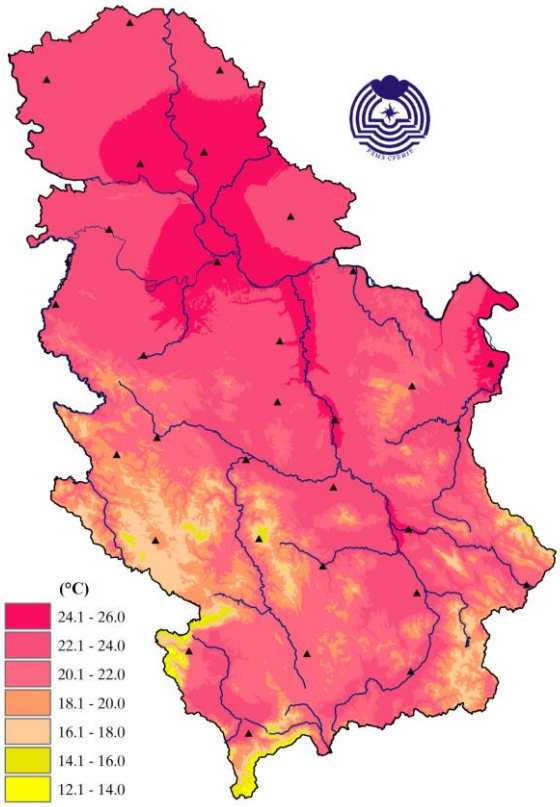


Figure 2. Spatial distribution of mean monthly air temperature (ºC)

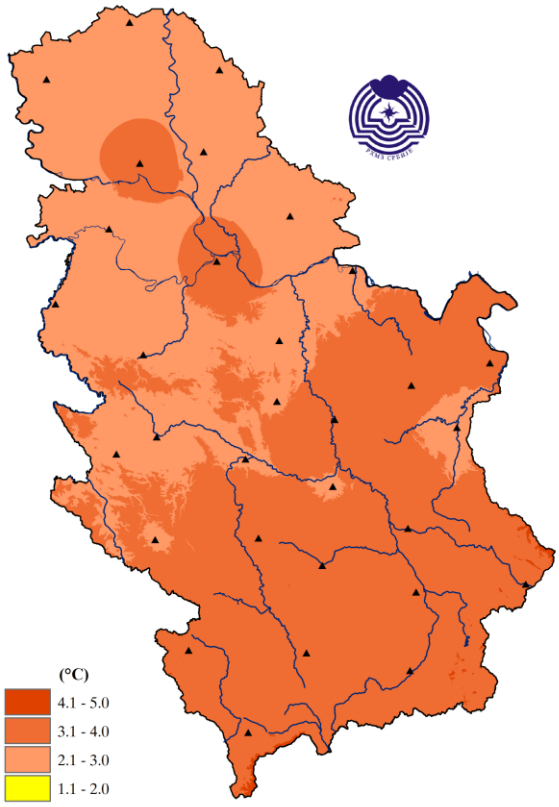


Figure 3. Spatial distribution of mean monthly air temperature anomaly (ºC)

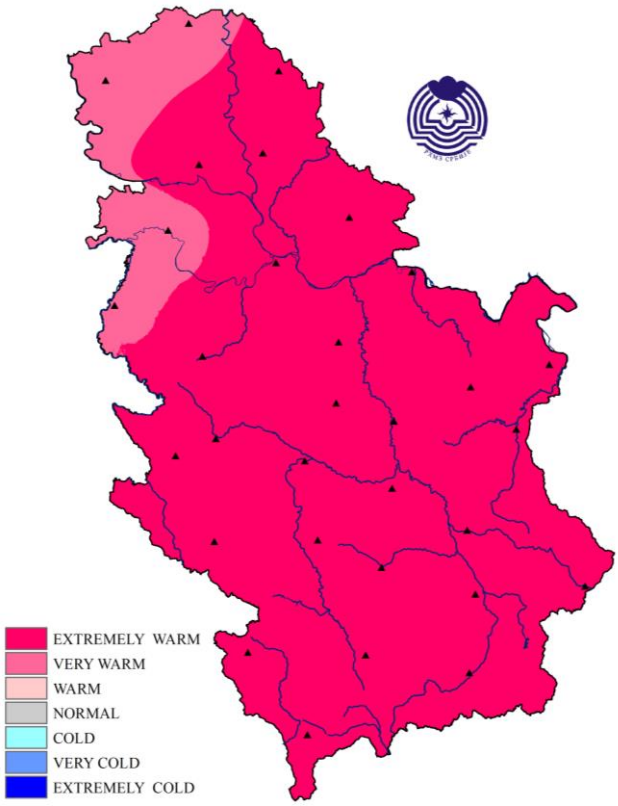


Figure 4. Spatial distribution of the mean monthly air temperature using percentile method

Mean daily air temperature in Belgrade, based on the percentile method, was in the following categories: warm and very warm most of June, normal in the middle of the first and third decade, and cold at the beginning of the second decade. Mean daily air temperature was in the category of extremely warm at the end of the first and at the end of the second 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.

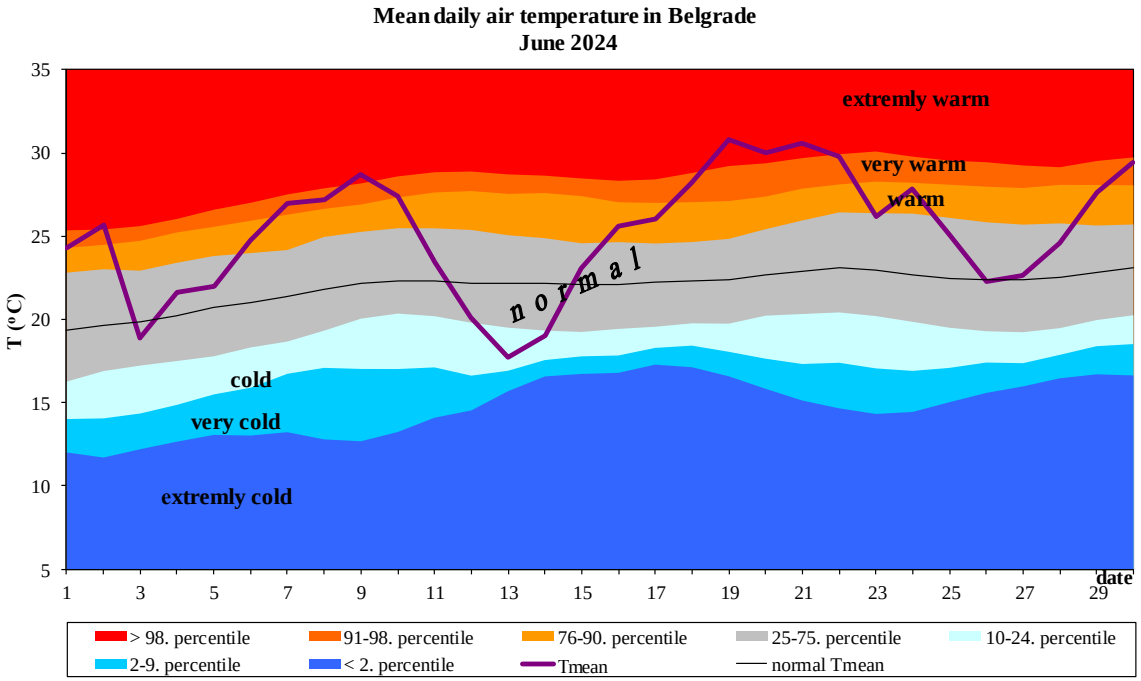


Figure 5. Daily course of the mean daily air temperature and accompanying percentiles for Belgrade

Maximum air temperature

Mean maximum June air temperature ranged from 29,3ºC in Pozega to 32,2ºC in Leskovac, while Belgrade observed air temperature of 30,4°C. On the mountains, mean maximum June air temperature ranged from 19,8ºC at Kopaonik to 25,8ºC in Sjenica.

Based on the percentile method, mean maximum air temperature was in the category of extremely warm in most of the country, very warm category in Sombor, Banatski Karlovac, Loznica, Sremska Mitrovica, Belgrade, Palic and Zlatibor.

The highest maximum daily air temperature of 38,4ºC was measured in Valjevo on June 22. On the same day, Belgrade observed air temperature of 37,5ºC. On June 21 and 22, Sjenica observed air temperature of 32,6ºC **breaking the previous record** of 32,4ºC set on June 24, 2021.

The highest number of summer[3] **and tropical**[4] **days since the record-keeping** began was registered at the majority of stations (*Table 2*).

Number of summer days ranged from 25 in Sremska Mitrovica to 30 days in Cuprija and Zajecar. As for the mountains, their number ranged from 3 days at Kopaonik to 18 in Sjenica. The recorded number of summer days was 5 to 10 days above the June average in most of the country *(Figure 6).*

The number of tropical days ranged from 12 in Pozega to 22 in Negotin, and on the mountains Zlatibor and Sjenica observed 3 and 4 days, respectively. Departure of the number of tropical days was 5 to 12 days above the June average in most of Serbia (*Figure 7*).

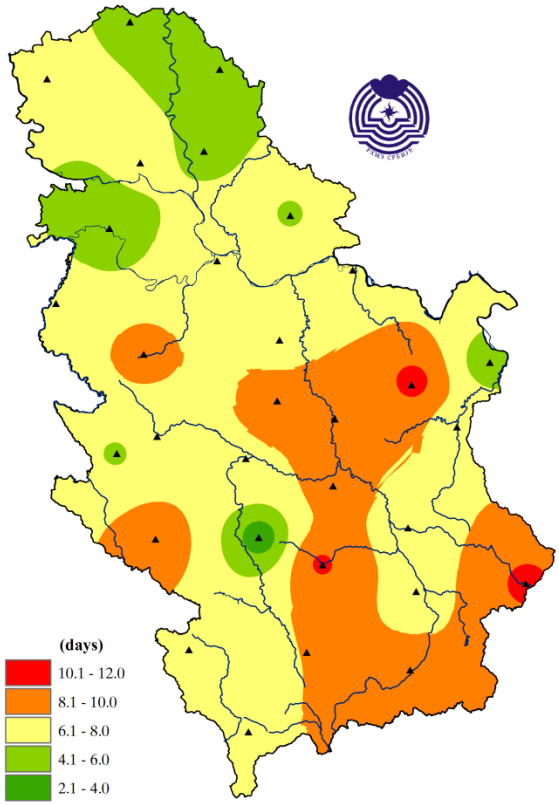


Figure 6. Deviation of the number of summer days from the normal

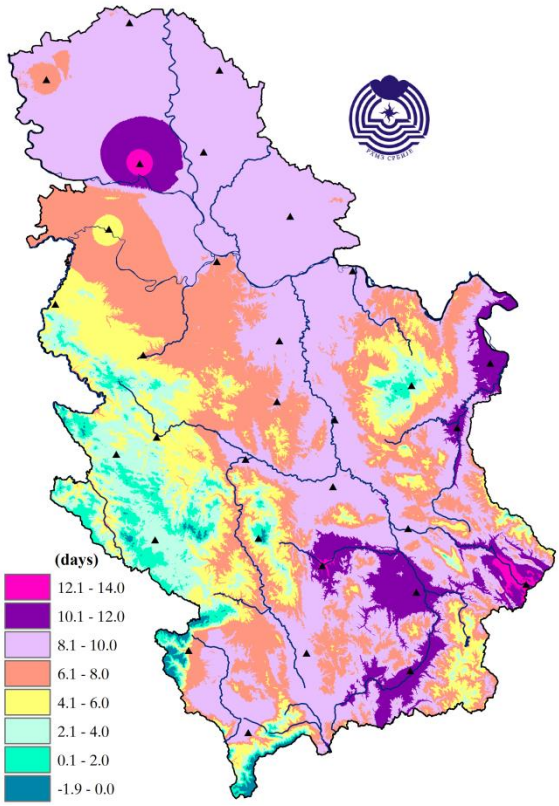


Figure 7. Deviation of the number of tropical days from the normal

[3] Summer day refers to a day with maximum daily air temperature 25°C and above
[4] Tropical day refers to a day with maximum daily air temperature 30°C and above

Table 2. Record-breaking number of summer and tropical days for June

MMS stations	Number of summer days June 2024	The previous record of sumer days	Year of the previous record	Number of tropical days June 2024	The previous record of tropical days	Year of the previous record
NOVI SAD	-	-	-	**20**	18	2003
KIKINDA	-	-	-	**17**	16	2012/2019
KRAGUJEVAC	**29**	28	2003/2023	-	-	-
CRNI VRH	**14**	9	2000/2003	-	-	-
SJENICA	**18**	17	2012	-	-	-
KRALjEVO	-	-	-	**17**	16	2012
KOPAONIK	**3**	2	2021	-	-	-
KURSUMLIJA	**29**	28	2003/2012	**19**	17	2012
CUPRIJA	**30**	29	2012/2022	-	-	-
LESKOVAC	-	-	-	**21**	20	2012
ZAJECAR	**30**	29	2003/2012	**21**	18	2012
DIMITROVGRAD	**29**	27	2003/2012	**20**	15	2012
VRANjE	**29**	28	1937/2012	**19**	16	1927/2012

There were two heat waves[5] recorded in June in Serbia. The onset of the the first heat wave was registered at the end of the first decade and beginning of the second decade of June in Cuprija, Negotinu Zaječar, Vranje, Dimitrovgrad and Leskovac. The second heat wave was observed at the end of the second and beginning of the third decade affecting most of the country (*Table 3).*

Table 3. Heat waves in Serbia

HEAT WAVES IN SERBIA - JUNE 2024

(relative to the 1991-2020 base period)

JUNE

station/day	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
PALIC																		VW	EW	VW	EW	EW								
SOMBOR																		VW	EW	EW	EW	VW								
KIKINDA																		VW	EW	EW	EW	EW								
ZRENJANIN																		VW	EW	EW	EW	EW								
NOVI SAD																		VW	EW	EW	EW	EW								
SR.MITROVICA																														
BELGRADE																		VW	EW	EW	EW	EW								
LOZNICA																		VW	EW	EW	EW	EW								
VALJEVO																		VW	EW	VW	EW	EW								
V.GRADISTE																														
SM.PALANKA																		VW	EW	EW	EW	EW								
KRAGUJEVAC																		VW	EW	EW	EW	EW								
KRALJEVO																		VW	EW	EW	VW	EW								
POZEGA																		VW	EW	EW	EW	EW								
ZLATIBOR																														
CUPRIJA							EW	EW	VW	EW	VW							EW	EW	EW	EW	EW	VW	VW						
KRUSEVAC																		VW	EW	EW	EW	EW								
NEGOTIN						VW	VW	EW	VW	EW																				
ZAJECAR							VW	EW	VW	EW	VW																			
CRNI VRH																														
KOPAONIK																	VW	EW	EW	EW	EW	EW	EW							
SJENICA																		VW	EW	VW	EW	EW								
NIS																		VW	EW	EW	EW	EW								
VRANJE							EW	VW	VW	EW	VW	VW	VW					VW	EW	EW	EW	EW								
DIMITROVGRAD							VW	VW	VW	EW	VW	VW					VW	EW	EW	EW	EW	EW	VW	VW	VW	VW	VW			
LESKOVAC							EW	VW	VW	EW	VW						VW	EW	EW	EW	EW	EW	VW							
KURSUMLIJA																		VW	EW	VW	EW	EW								
B.KARLOVAC																		EW	EW	EW	VW	EW								

EW	EXTREMELY WARM
VW	VERY WARM

[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

Figure 8 shows daily course of the maximum daily air temperature and the accompanying percentiles for Belgrade in June 2024 and for the stations Sombor, Novi Sad, Loznica, Negotin, Kragujevac, Zlatibor, Nis and Vranje are given in the Appendix.

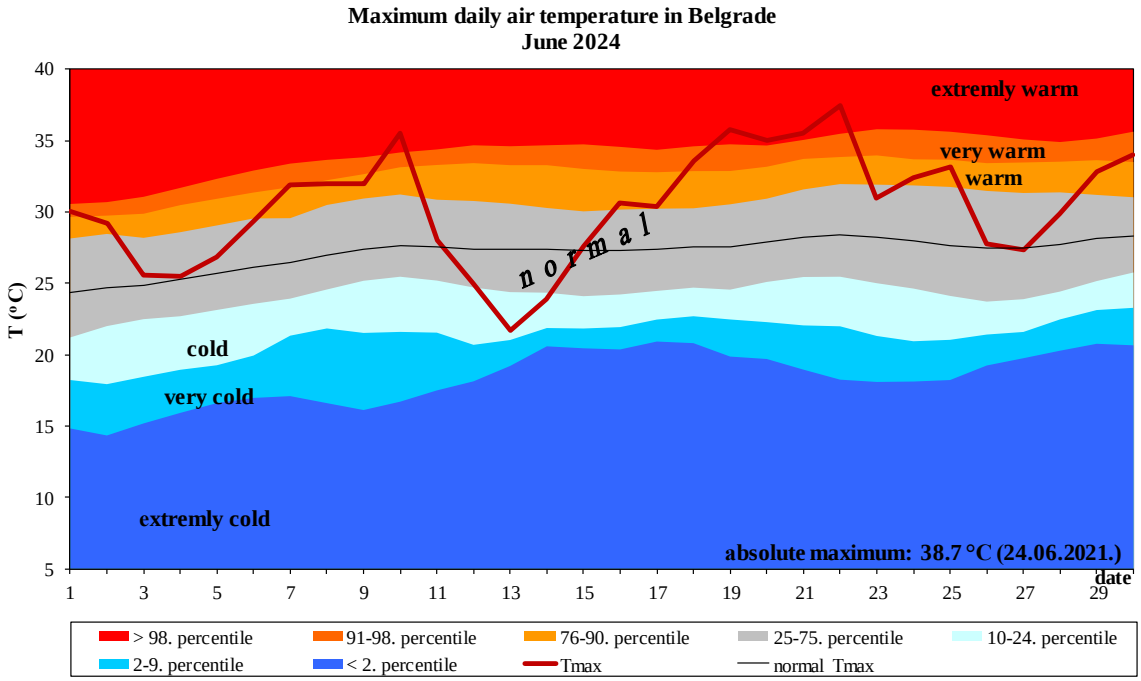


Figure 8. Daily course of the maximum daily air temperature and accompanying percentiles for Belgrade

Minimum air temperature

Mean minimum June air temperature ranged from 14,5ºC in Dimitrovgrad to 19,6ºC in Belgrade. As for the mountains, mean minimum air temperature ranged from 10,6ºC at Kopaonik to 15,0ºC at Crni Vrh.

Based on the percentile method, mean minimum air temperature was in the following categories: extremely warm in most of the country, very warm in Palic, Sombor, Kikinda, Loznica, Sremska Mitrovica, Veliko Gradiste and Pozega.

The lowest minimum daily air temperature of 5,8ºC was measured at Kopaonik on June 14. This is **the highest minimum June air** temperature since record-keeping began at this station. The previous record of 4,2ºC was set on June 14, 1954 and June 16, 2008.

In the lowland, the highest daily air temperature of 7,3ºC was measured on June 15 in Dimitrovgrad while Belgrade observed the lowest monthly air temperature of 12,9ºC on June 14.

In most of the country, there were tropical nights[6]. Pozega, Kursumlija, Leskovac, Zajecar, Dimitrovgrad and Vranje didn't observe any tropical nights while Belgrade saw 15 tropical nights. The highest number of tropical nights was registered in the north of the country, while 5 MMS observed record-breaking number of tropical nights for June (*Table 4).* One tropical night was recorded at Crni Vrh. The observed number of frost days was 4 to 7 days above the June average.

[6] Tropical night refers to a day with minimum daily air temperature 20°C and above

Table 4. Record-breaking number of tropical nights for June

MMS stations	Number of tropical nights June 2024	The previous record of tropical nights	Year of the previous record
PALIC	**9**	7	2006
SOMBOR	**5**	4	2010
NOVI SAD	**7**	5	2021
B.KARLOVAC	**5**	4	2021
BELGRADE	**15**	13	2012

Figure 9 shows assessment of the minimum and maximum air temperature in Serbia for June based on the tercile distribution relative to the 1991-2020 base period. It can be noted that the mean minimum and mean maximum air temperature were considerably above the threshold of upper tercile and their values were **the highest** in the series since 1981.

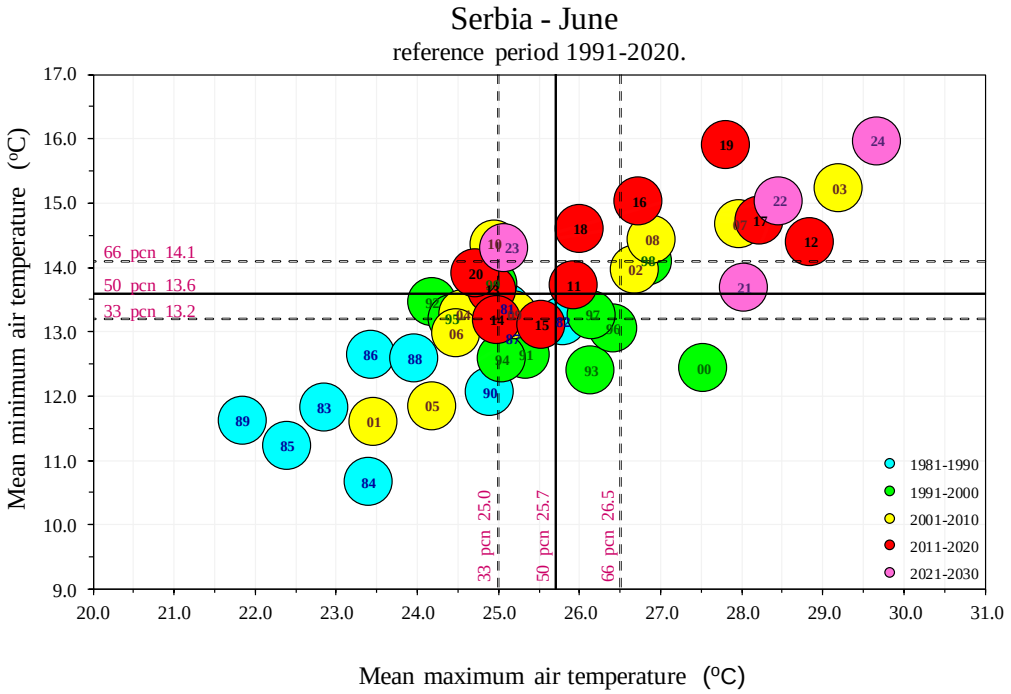


Figure 9. Assessment of minimum and maximum air temperature for Serbia with the accompanying terciles in relation to the 1991-2020 base period

Figure 10 shows daily course of the minimum daily air temperature and the accompanying percentiles for Belgrade in June 2024, and for the stations Sombor, Novi Sad, Loznica, Negotin, Kragujevac, Zlatibor, Nis and Vranje are given in the Appendix.

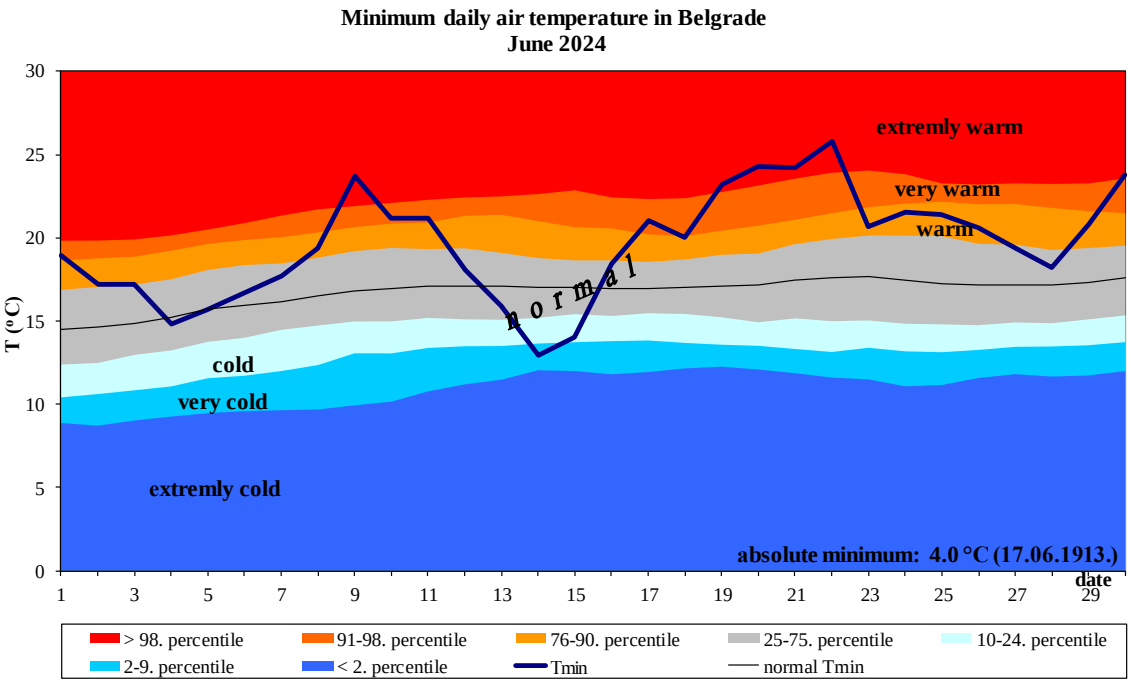


Figure 10. Daily course of the minimum daily air temperature and accompanying percentiles for Belgrade

PRECIPITATION

June precipitation sums ranged from 42,4 mm in Zrenjanin to 124,2 mm in Belgrade (*Figure 11*).

Precipitation totals for the 1991-2020 base period ranged from 50% in Zrenjanin to 144% in Nis (*Figure 12*).

Based on the percentile method, precipitation sums were in the following categories: normal category in most of the country, dry in Novi Sad, Zrenjanin, Sremska Mitrovica and Zlatibor, rainy in Nis (*Figure 13*).

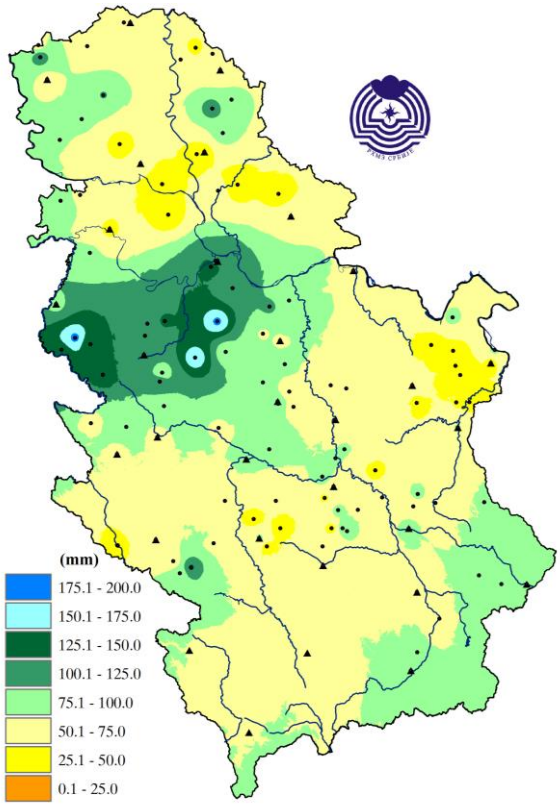


Figure 11. Spatial distribution of the monthly precipitation sums (mm) according to data from 28 major meteorological, 21 climatological and 71 rain gauge stations

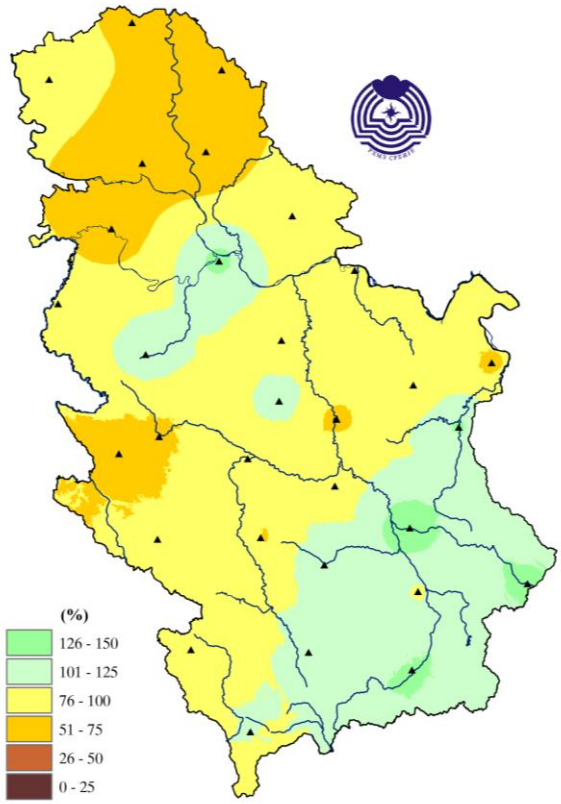


Figure 12. Spatial distribution of the monthly precipitation sums in the percentages of normal for the 1991–2020 base period

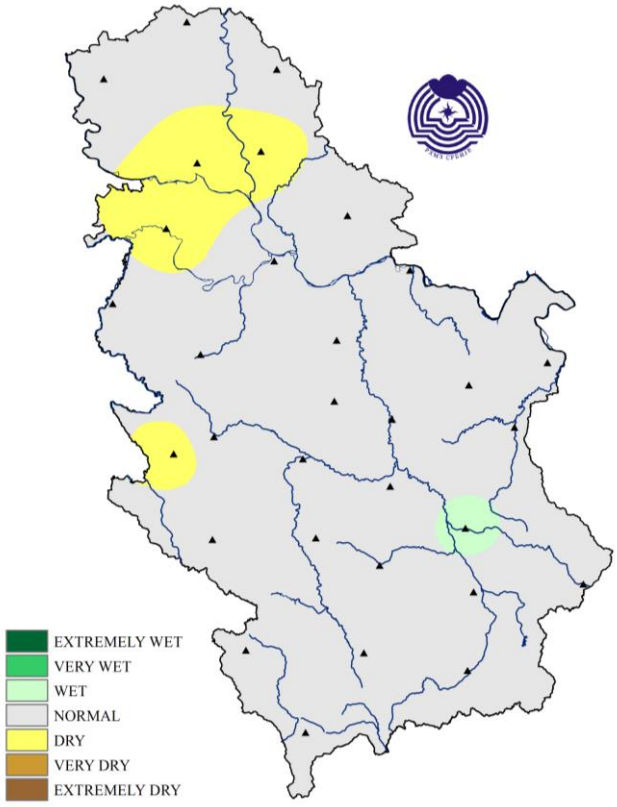


Figure 13. Monthly precipitation sums according to the percentile method

The highest daily precipitation sum of 82,5 mm was recorded in Belgrade on June 28. Elsewhere, there weren't any days with precipitation above 50 mm.

Number of days with precipitation ranged from 7 in Vranje to 14 in Sombor, Kikinda and Valjevo, whereas Zlatibor observed 15 (*Figure 14*). The observed number of days with precipitation was around the June average in most of the country (*Figure 15*).

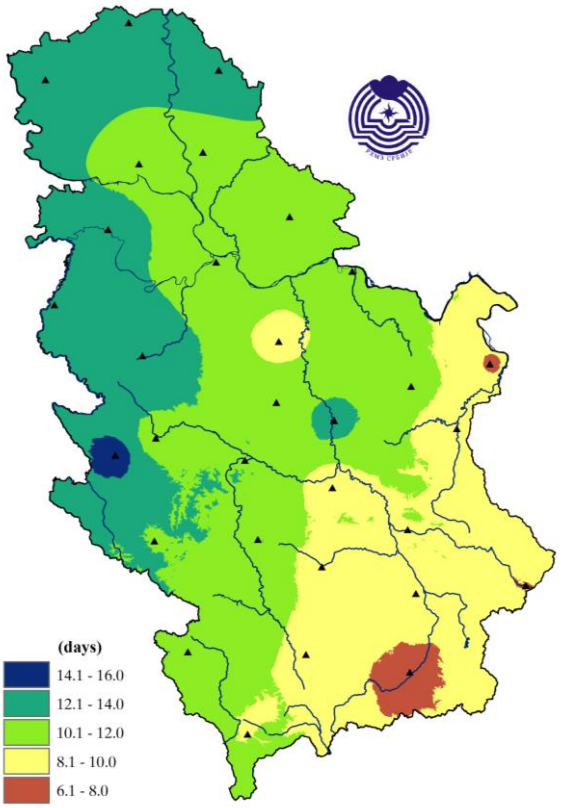


Figure 14. Spatial distribution of number of days with precipitation

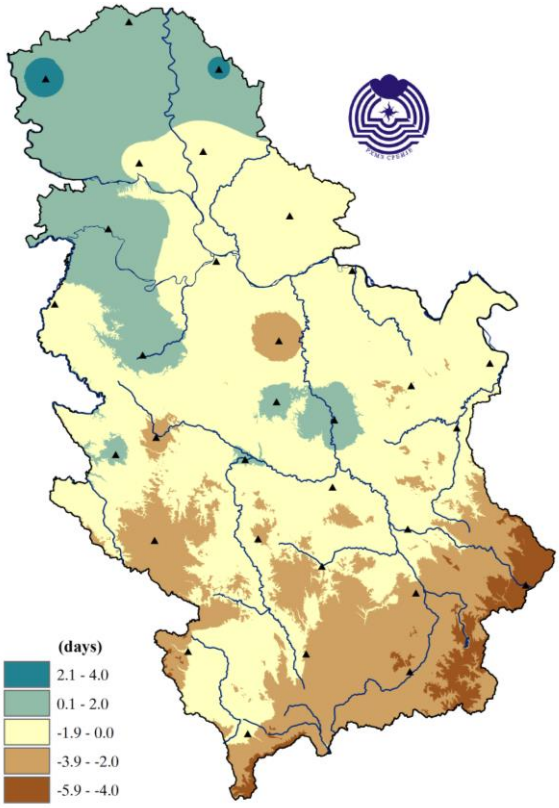


Figure 15. Spatial distribution of deviation of number of days with precipitation

Figure 16 shows assessment of air temperature and precipitation sums for Serbia for June based on the tercile distribution relative to the 1991 – 2020 base period. It can be noted that June 2024 was marked by air temperature significantly above the upper tercile threshold (**the highest** since 1981) and precipitation sums within the average.

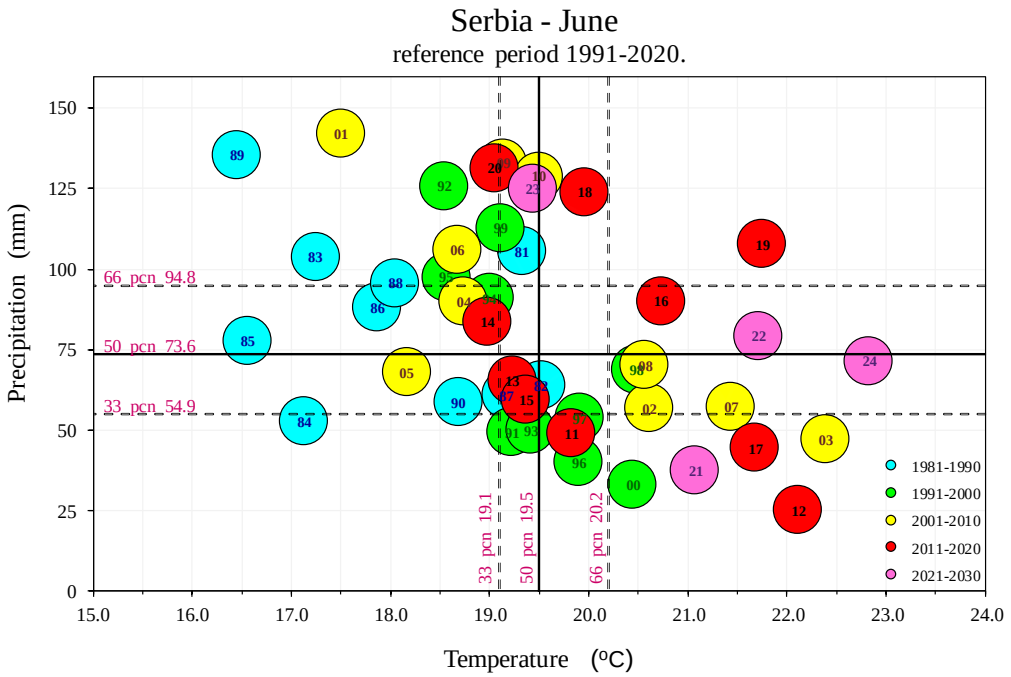


Figure 16. Assessment of air temperature and precipitation for Serbia with the accompanying terciles in relation to the 1991-2020 base period

Figure 17 show daily and cumulative precipitations sums with averaged normal 1991-2020 for June in Belgrade, and for the stations Sombor, Novi Sad, Loznica, Negotin, Kragujevac, Zlatibor, Nis and Vranje precipitation sums are given in Appendix.

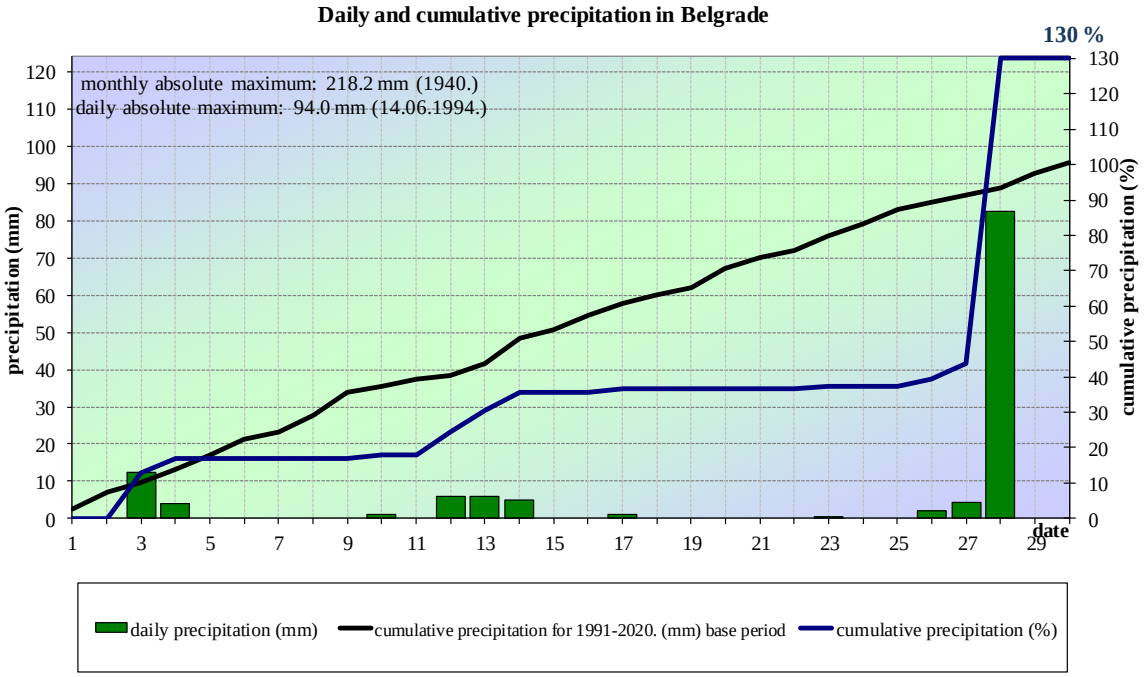


Figure 17. Daily and cumulative precipitation in Belgrade

CLOUD COVER, BRIGHT AND CLOUDY DAYS

Mean June cloud cover was slightly below the average, ranging from 3/10 to 5/10. Figures 18, 19 and 20 show average daily cloud cover for Belgrade, Novi Sad and Leskovac.

Number of bright days[7] ranged from 2 in Sjenica to 11 in Nis and Leskovac. Belgrade observed 6 bright days. The observed number of bright days was 2 to 4 days above the June average in the south and southwest.

Cloudy days [8] were not registered in Veliko Gradiste and Sjenica, whereas the highest number of cloudy days, total of 5 days was recorded in Novi Sad and Loznica; Belgrade observed 2 cloudy days. Number of cloudy days was 2 to 4 days below the June average in most of the country.

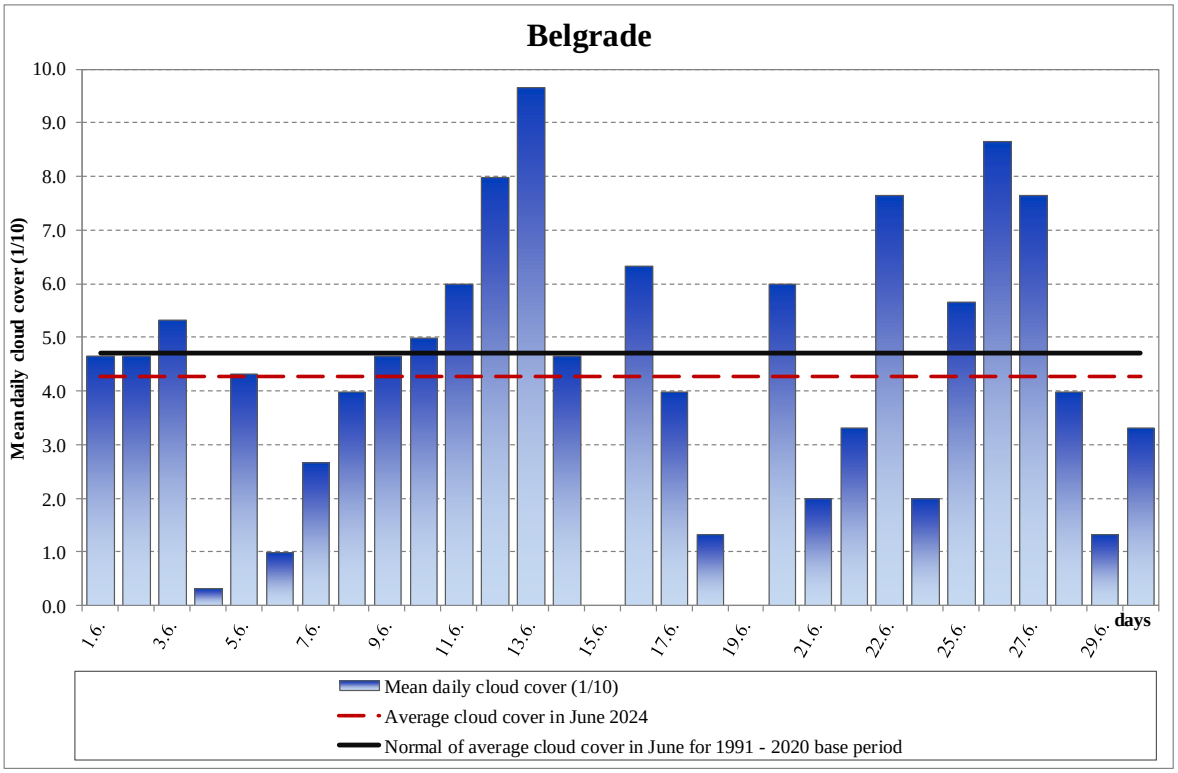


Figure 18. Mean daily cloud cover in Belgrade

[7] Bright day refers to a day with cloud cover less than 2/10
[8] Cloudy day refers to a day with cloud cover over 8/10

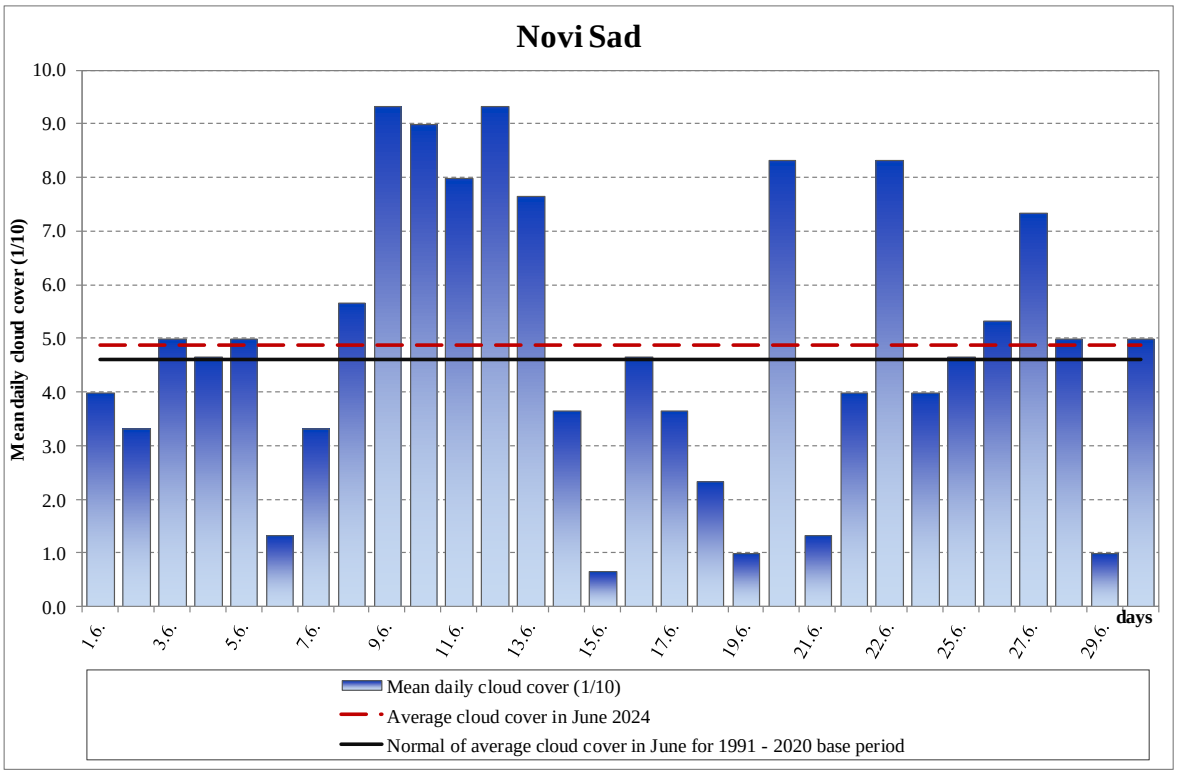


Figure 19. Mean daily cloud cover in Novi Sad

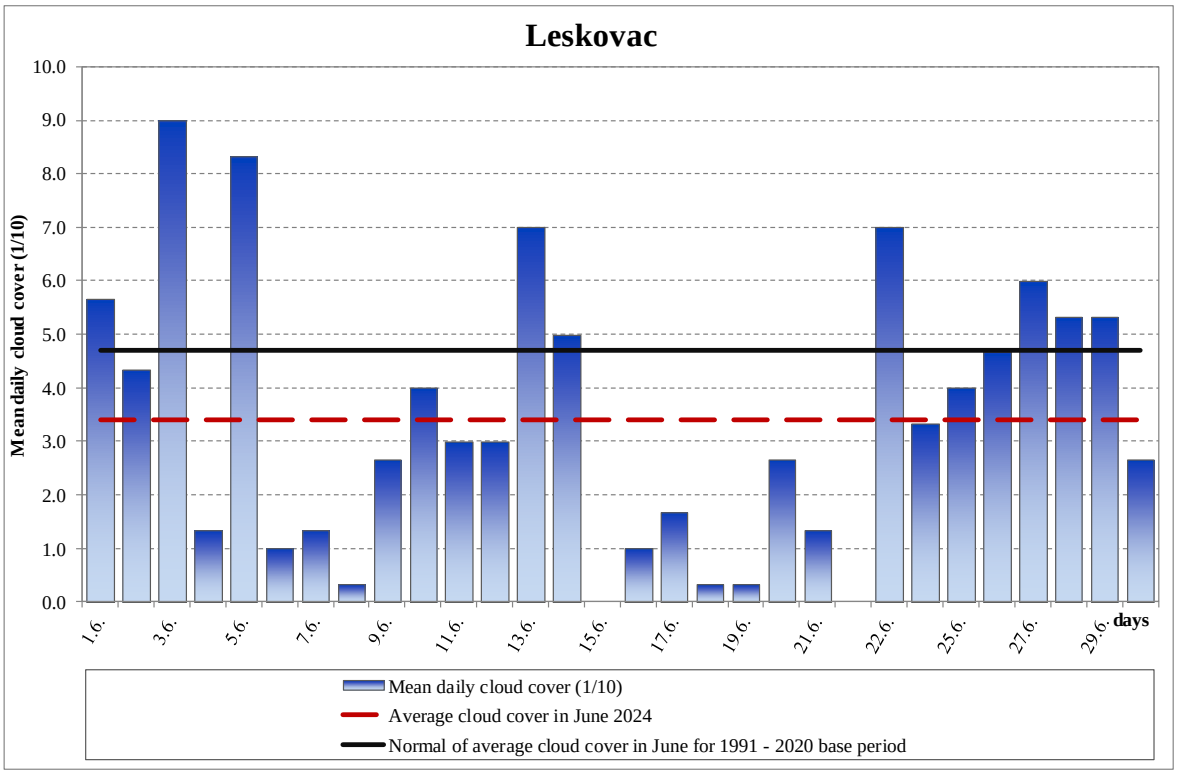


Figure 20. Mean daily cloud cover in Leskovac

SUNSHINE DURATION (INSOLATION)

June insolation ranged from 252,0 hours in Loznica to 324,9 hours in Vranje (*Figure 21*).

June insolation ranged from 99% in Loznica to 124% at Kopaonik relative to the normal for the 1991-2020 base period (*Figure 22*).

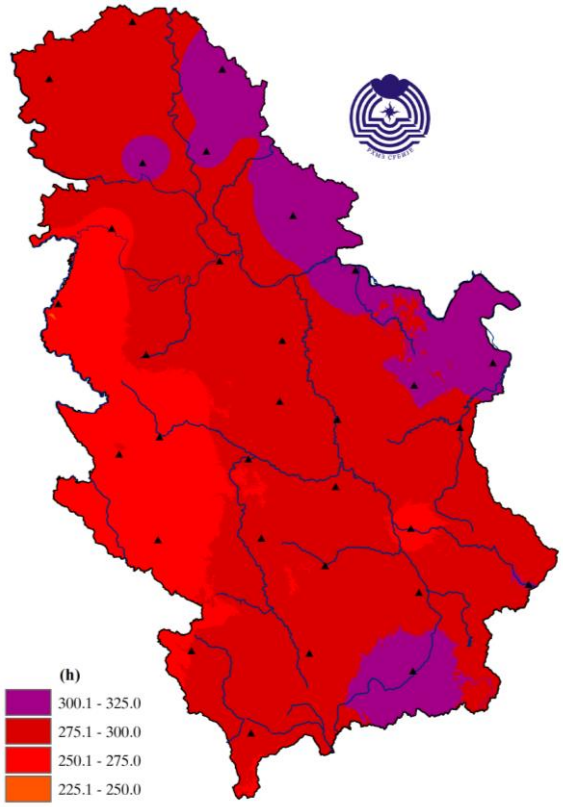


Figure 21. Insolation, expressed in hours

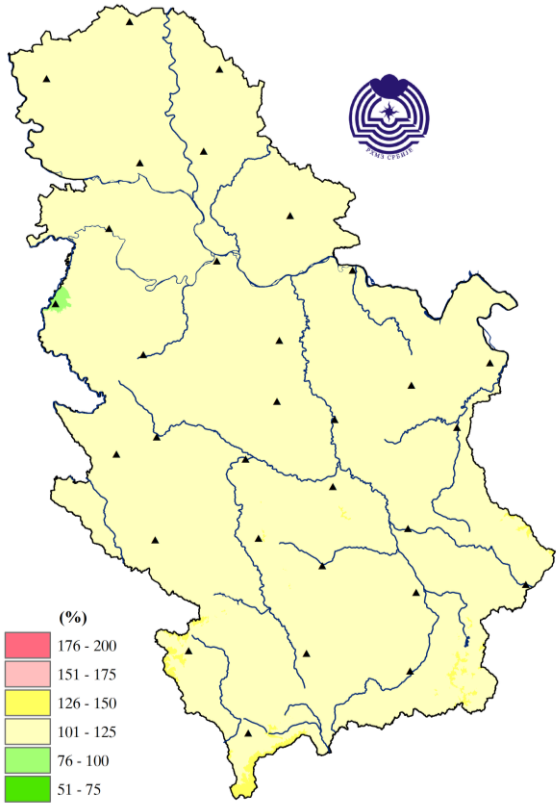


Figure 22. Insolation expressed in the percentages of normal

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

OVERVIEW OF THE SYNOPTIC SITUATION*

Occasionally unstable and dangerous weather; intensive advection of warm air mass from the southwest of the continent and North Africa, periods of very warm weather accompanied by Saharan dust, and several cold incursions with accompanying occasionally pronounced moisture depressions or surface low pressure from the northwest originating from the Alps and western Mediterranean region.

Period until the mid-decade was marked by unsettled weather, with scattered rain, thundershowers, more frequent in the west, southwest, east and northeast of the country. Additionally, severe weather events were observed during this period, due to the influence of cold front and low pressure from the northwest emanating from the Alps, and later from the western Mediterranean region, along with shallow moisture depressions in Central Europe and the Adriatic. The subsequent period was marked by the influx of warm air masses from the southwest causing a significant temperature rise. Occasional brief showers were observed at the end of the first decade in the east, southeast, as well as southwest, with more pronounced and frequent showers in the northern regions.

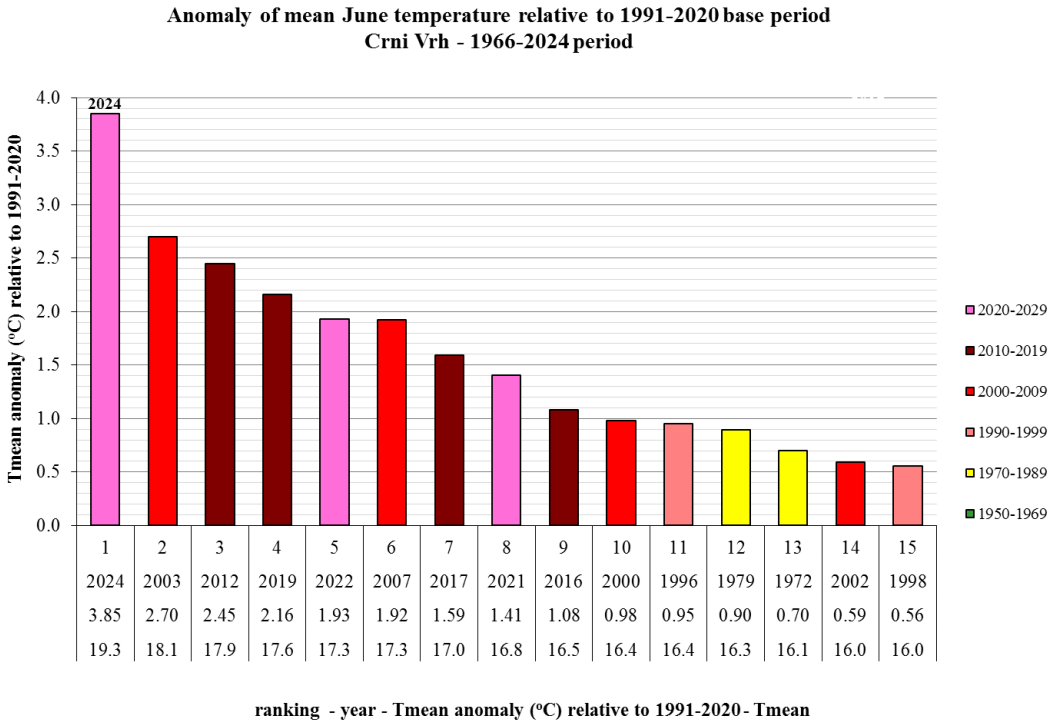
Unsettled weather continued throughout the beginning of the second decade, with local showers and thunderstorms accompanied by episodes of severe weather at places. The maintenance and further development of low pressure over the northern continent and a pronounced upper-air trough over the eastern Atlantic and western Europe initially strengthened the ridge and the incursion of warm air mass. Simultaneously, there was strengthening of the influence of pronounced southwesterly upper-air along with shallow disturbances within the surface low pressure across the south of the continent and the Balkans, on the frontal side of moisture depression from the western Mediterranean and Adriatic. The second half of the second decade was marked by intensive advection of the warm air mass from the North Africa and western Mediterranean producing very warm weather.

Following a period of very warm weather, the third decade brought dangerous changes in terms of severe weather events, stormy wind, hail and scattered heavy precipitation. These episodes occurred after the gradual disturbance of the warm ridge across the Balkans and influence of the series of waves of moist and unsettled air from the central Europe and western Mediterranean, i.e. Adriatic Sea within the low pressure and moist depression.

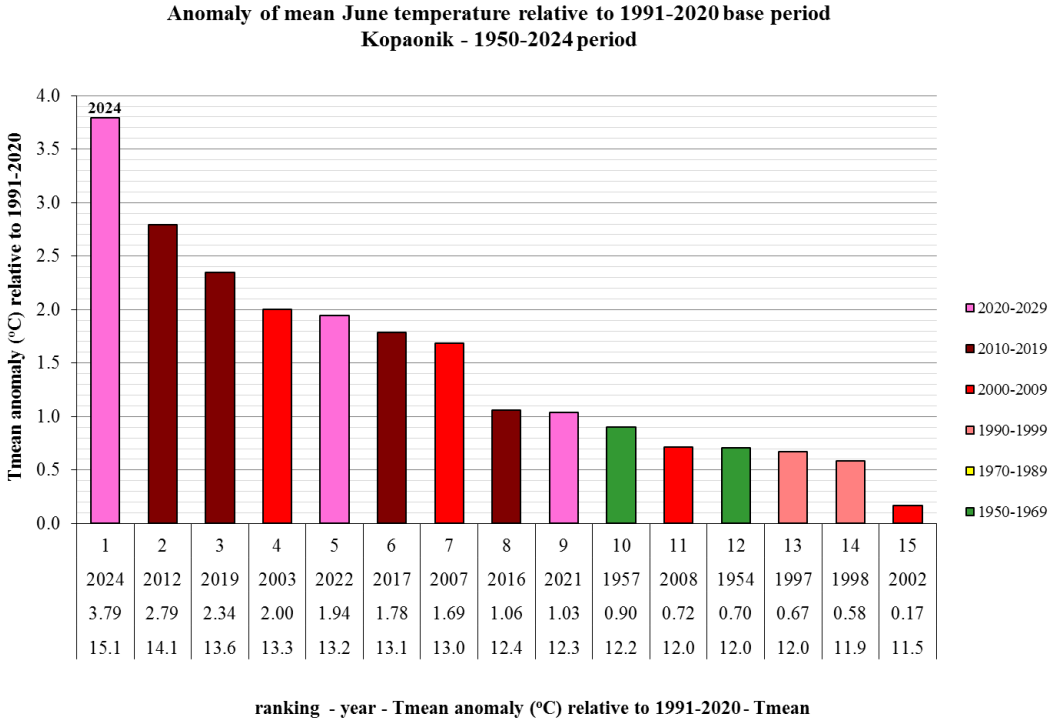
* National Center for Hydrometeorlogical Early Warning System

APPENDIX

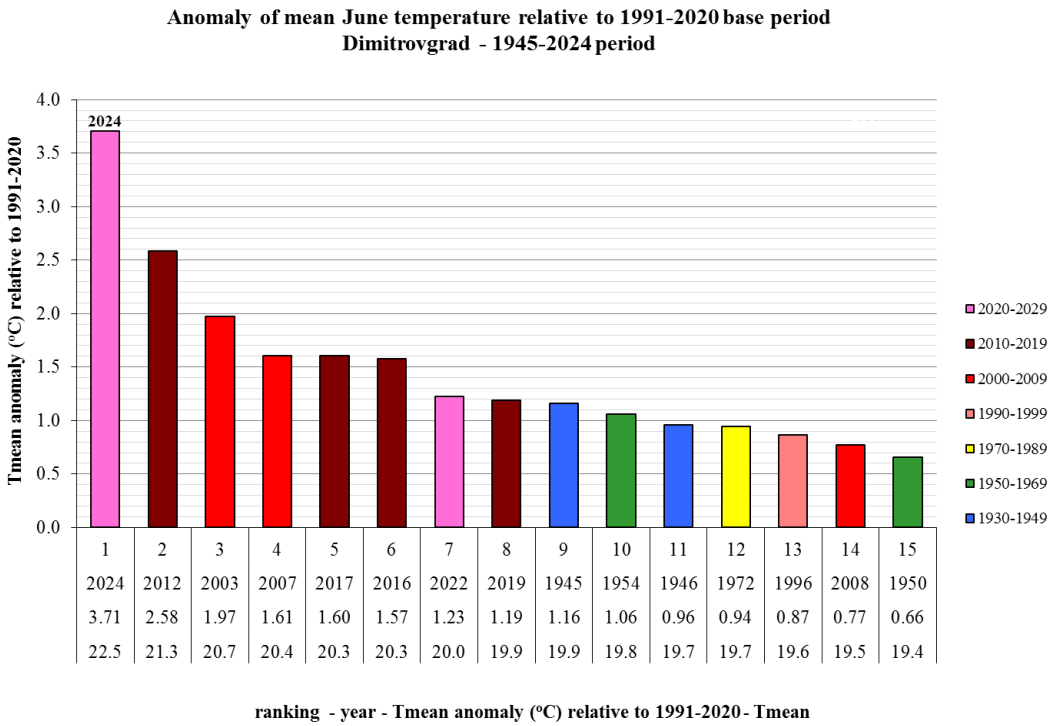
Ranks of the warmest June



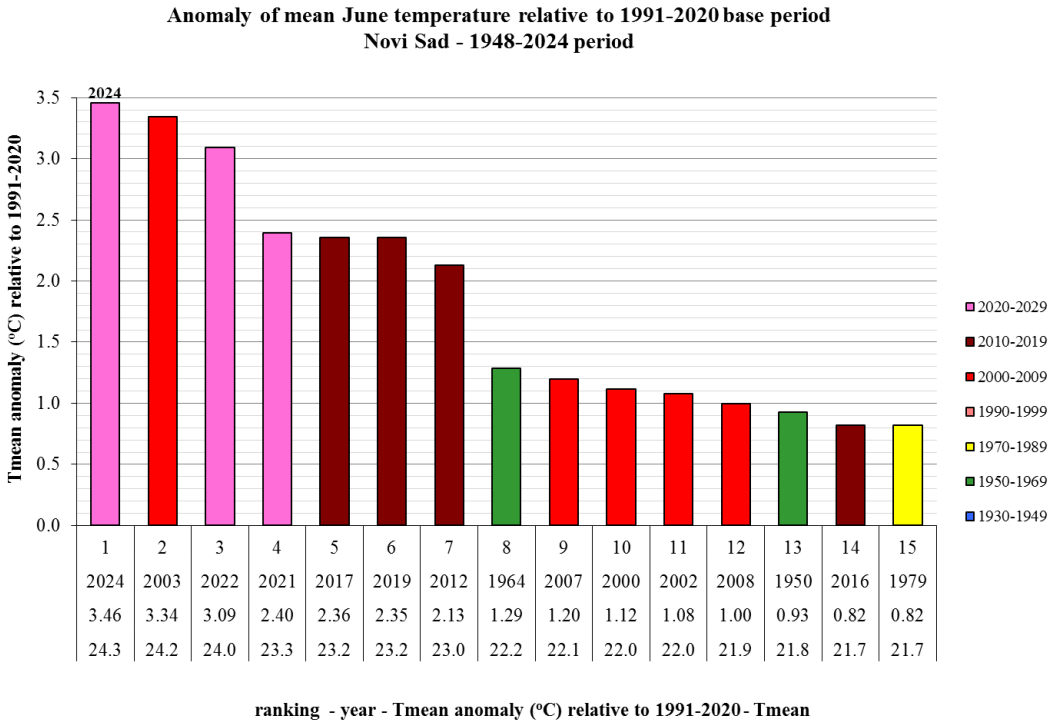
Appendix 1. Rank of the warmest June on Crni Vrh



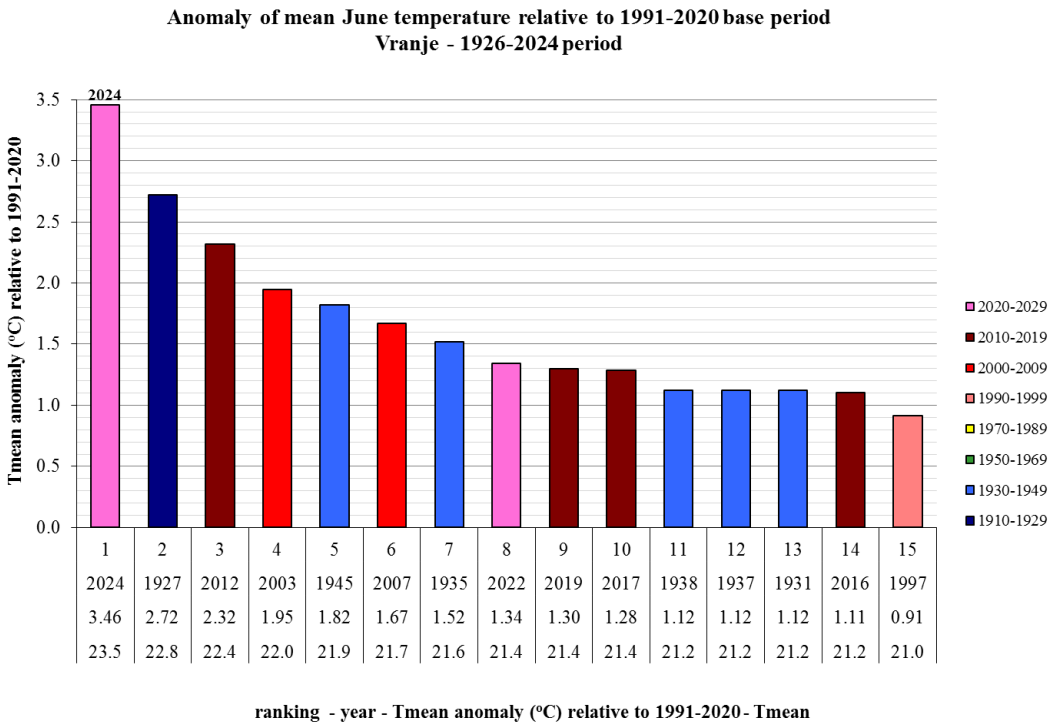
Appendix 2. Rank of the warmest June on Kopaonik



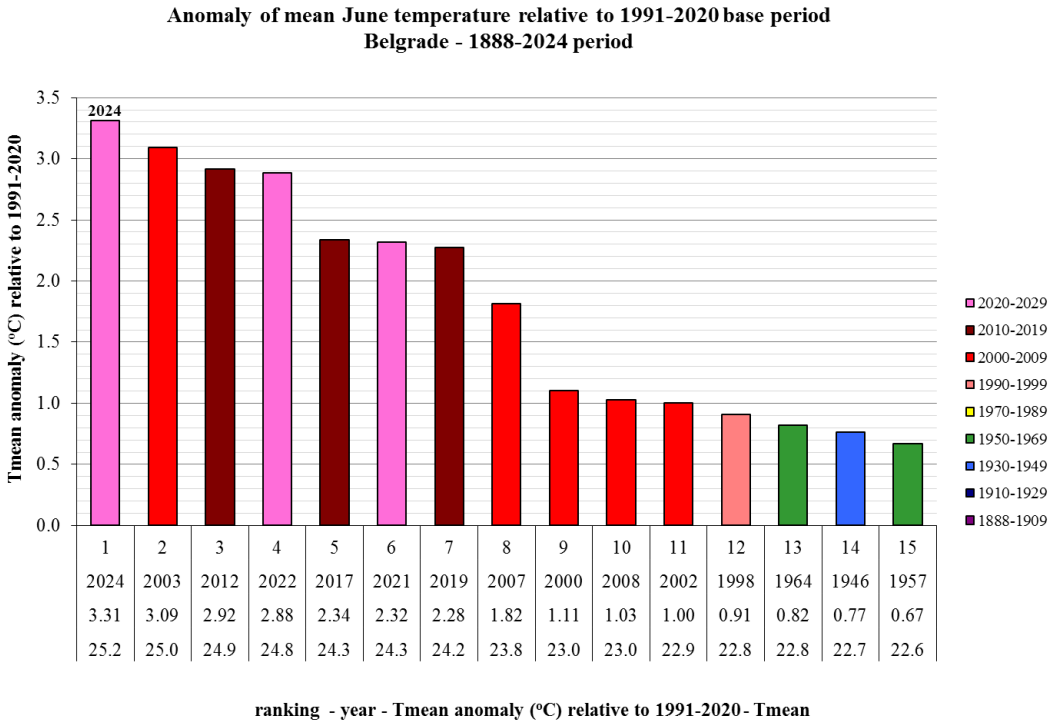
Appendix 3. Rank of the warmest June in Dimitrovgrad



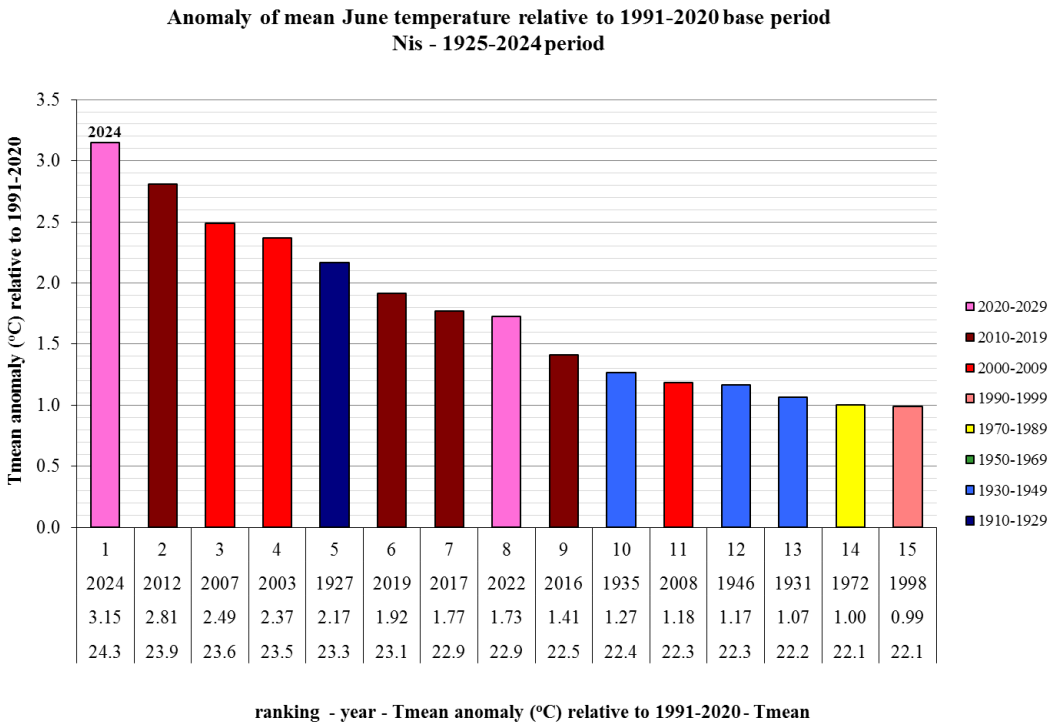
Appendix 4. Rank of the warmest June in Novi Sad



Appendix 5. Rank of the warmest June in Vranje

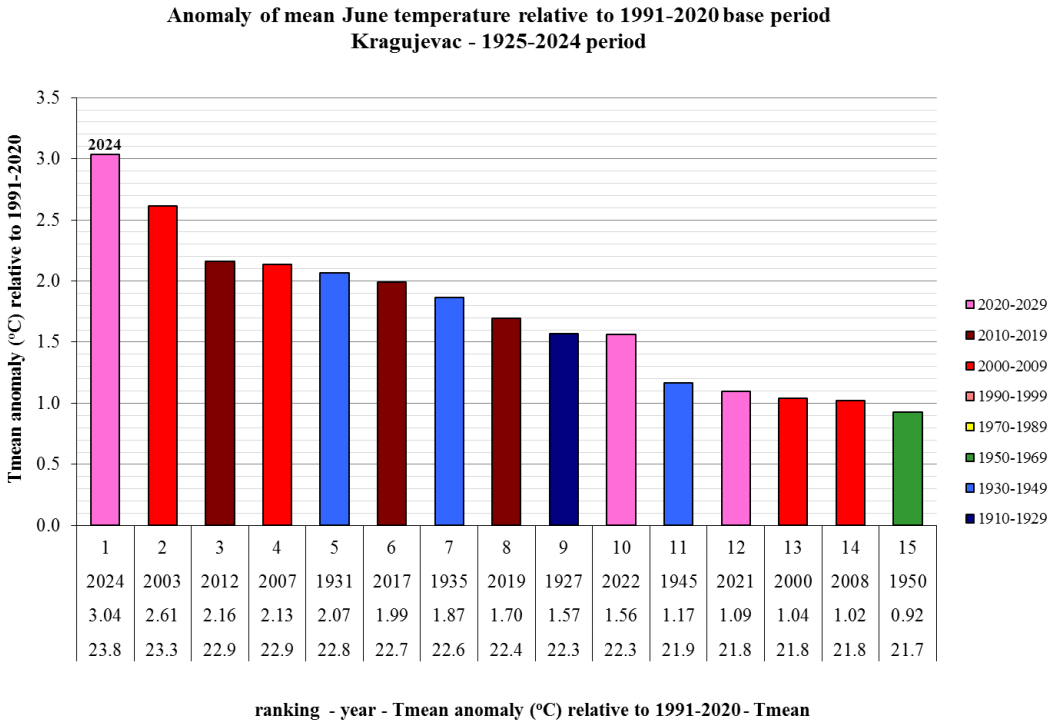


Appendix 6. Rank of the warmest June in Belgrade



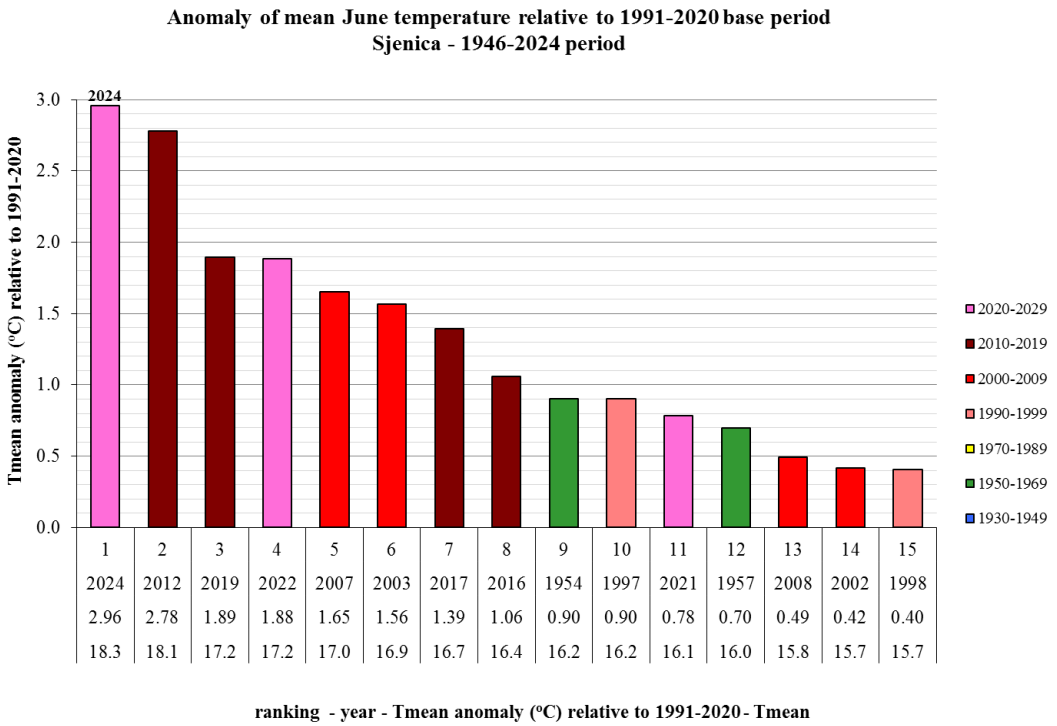
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2024	2012	2007	2003	1927	2019	2017	2022	2016	1935	2008	1946	1931	1972	1998
3.15	2.81	2.49	2.37	2.17	1.92	1.77	1.73	1.41	1.27	1.18	1.17	1.07	1.00	0.99
24.3	23.9	23.6	23.5	23.3	23.1	22.9	22.9	22.5	22.4	22.3	22.3	22.2	22.1	22.1

Appendix 7. Rank of the warmest June in Nis



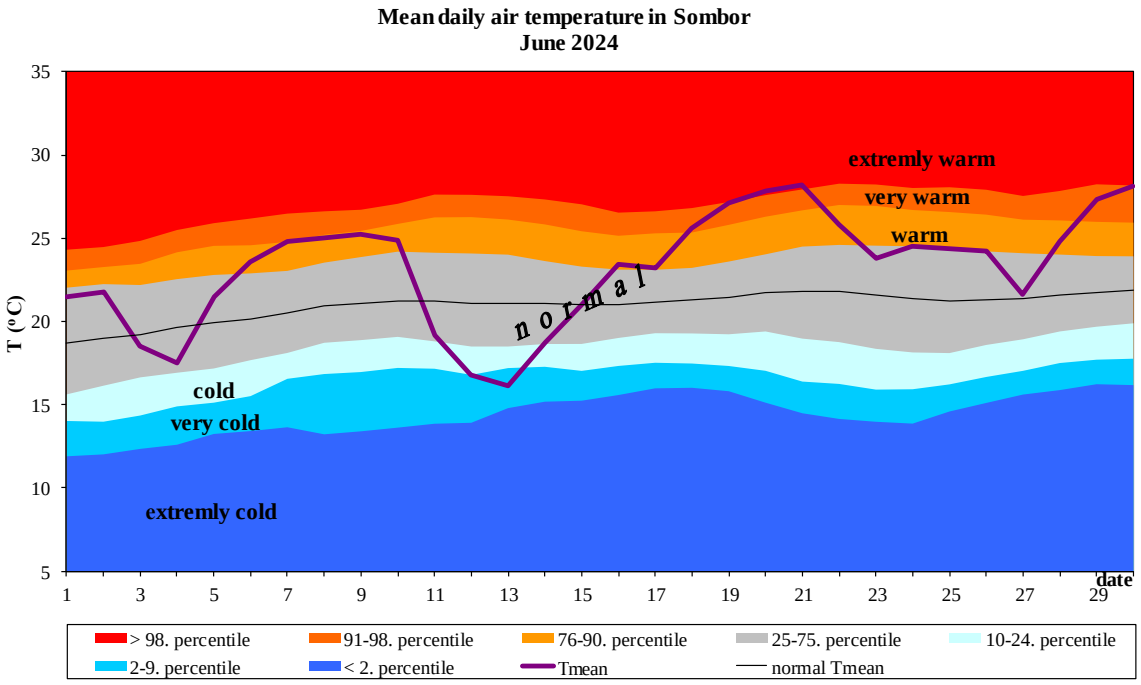
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2024	2003	2012	2007	1931	2017	1935	2019	1927	2022	1945	2021	2000	2008	1950
3.04	2.61	2.16	2.13	2.07	1.99	1.87	1.70	1.57	1.56	1.17	1.09	1.04	1.02	0.92
23.8	23.3	22.9	22.9	22.8	22.7	22.6	22.4	22.3	22.3	21.9	21.8	21.8	21.8	21.7

Appendix 8. Rank of the warmest June in Kragujevac

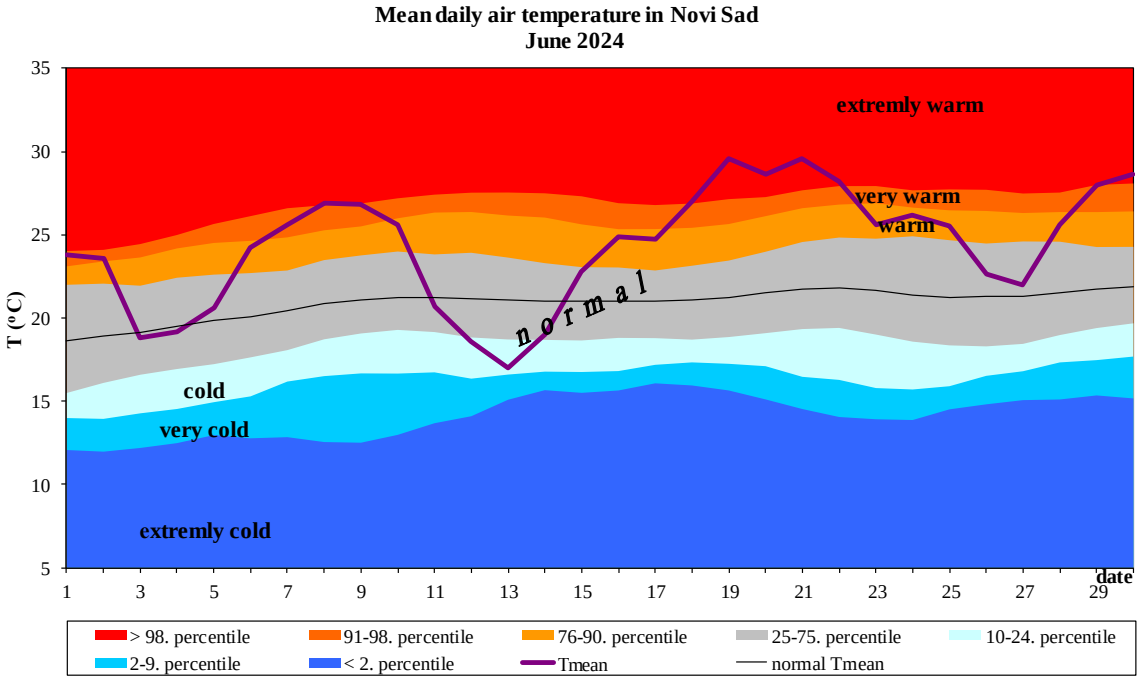


Appendix 9. Rank of the warmest June in Sjenica

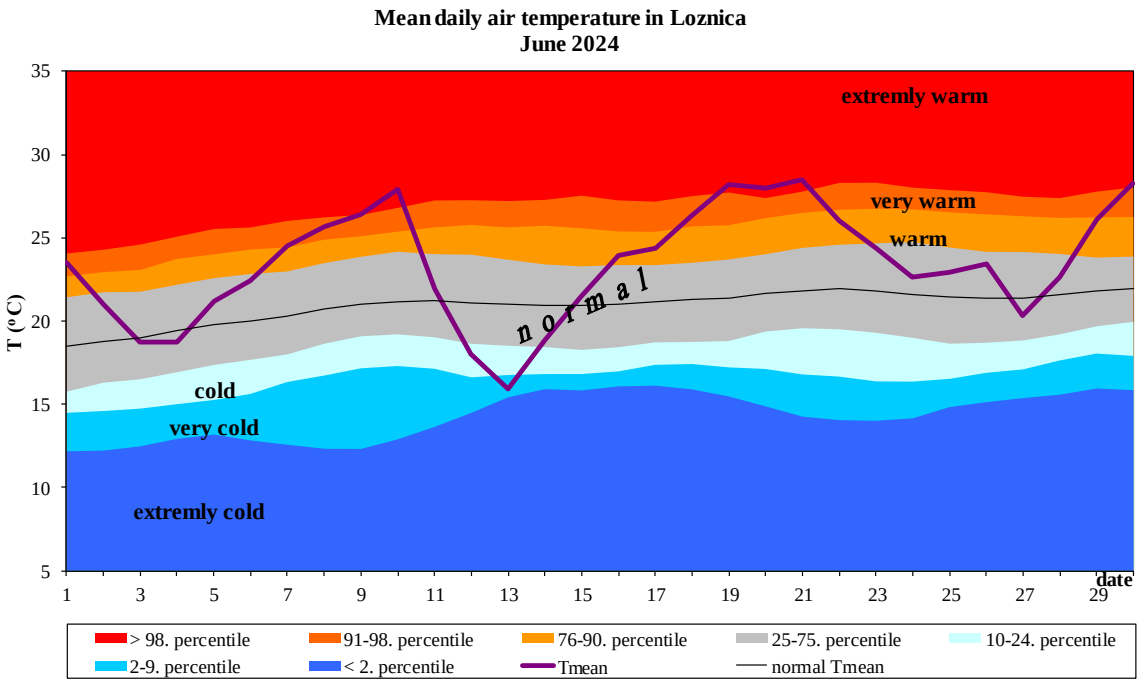
Mean air temperature



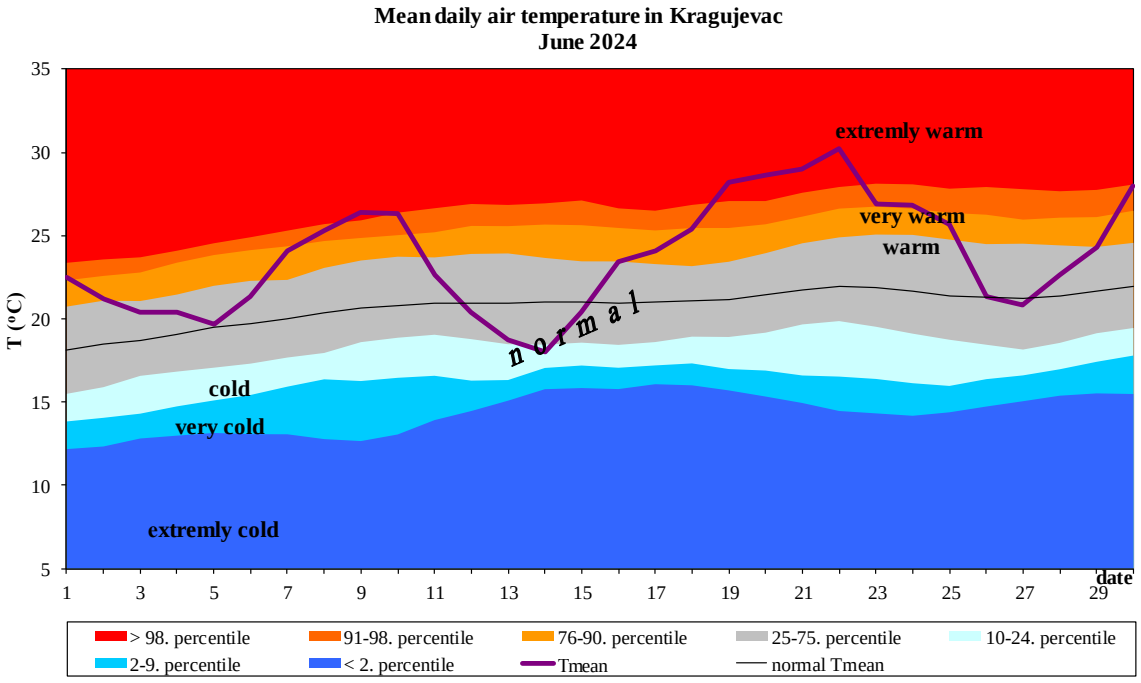
Appendix 10. Daily course of the mean daily air temperature and accompanying percentile for Sombor



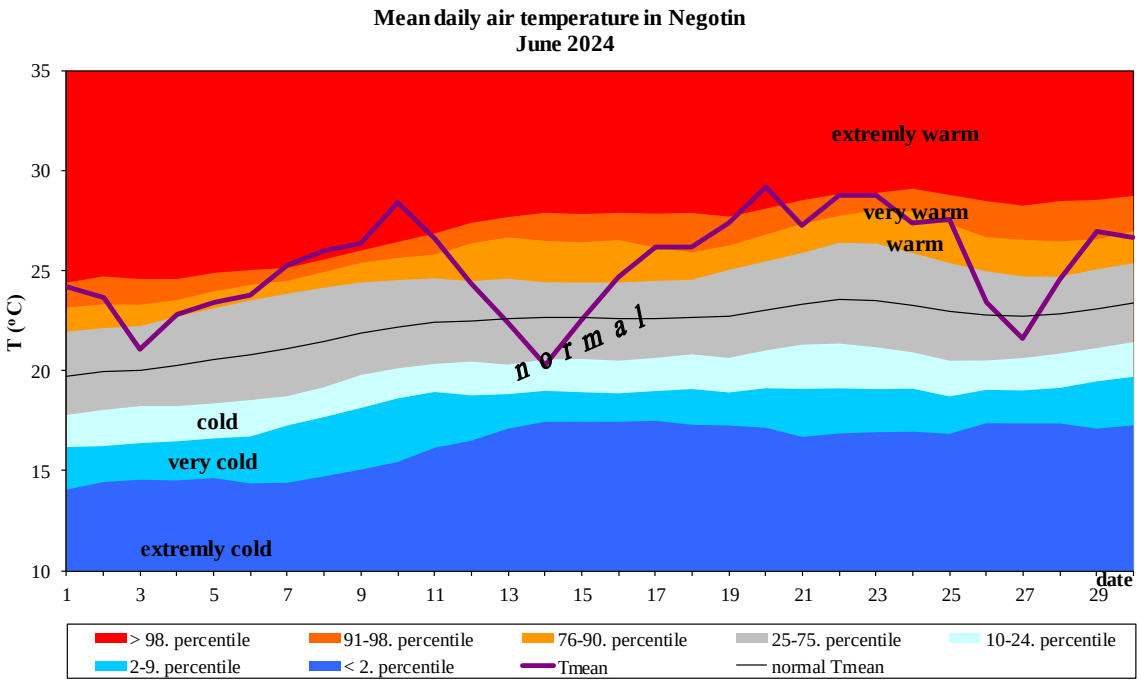
Appendix 11. Daily course of the mean daily air temperature and accompanying percentile for Novi Sad



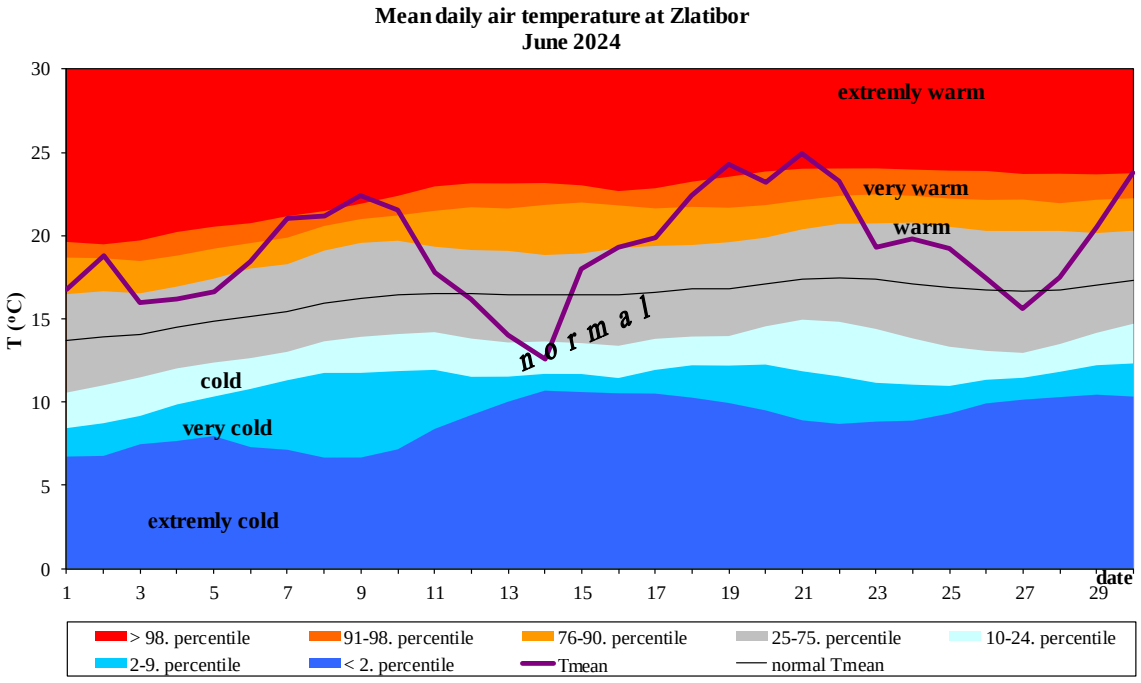
Appendix 12. Daily course of the mean daily air temperature and accompanying percentile for Loznica



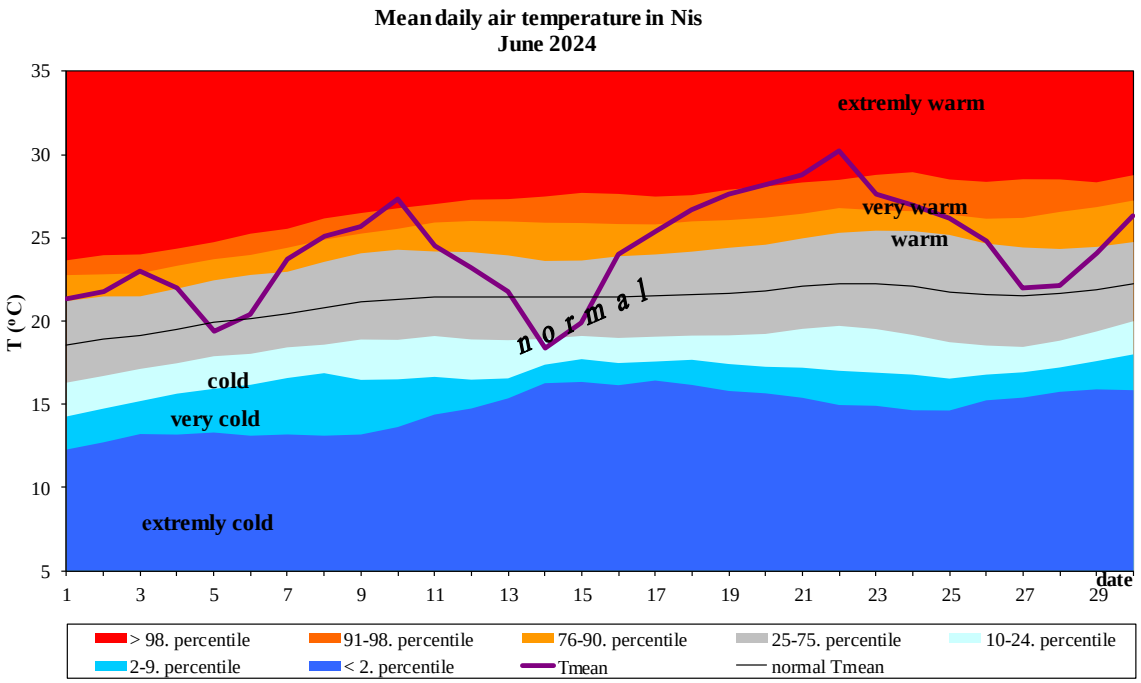
Appendix 13. Daily course of the mean daily air temperature and accompanying percentile for Kragujevac



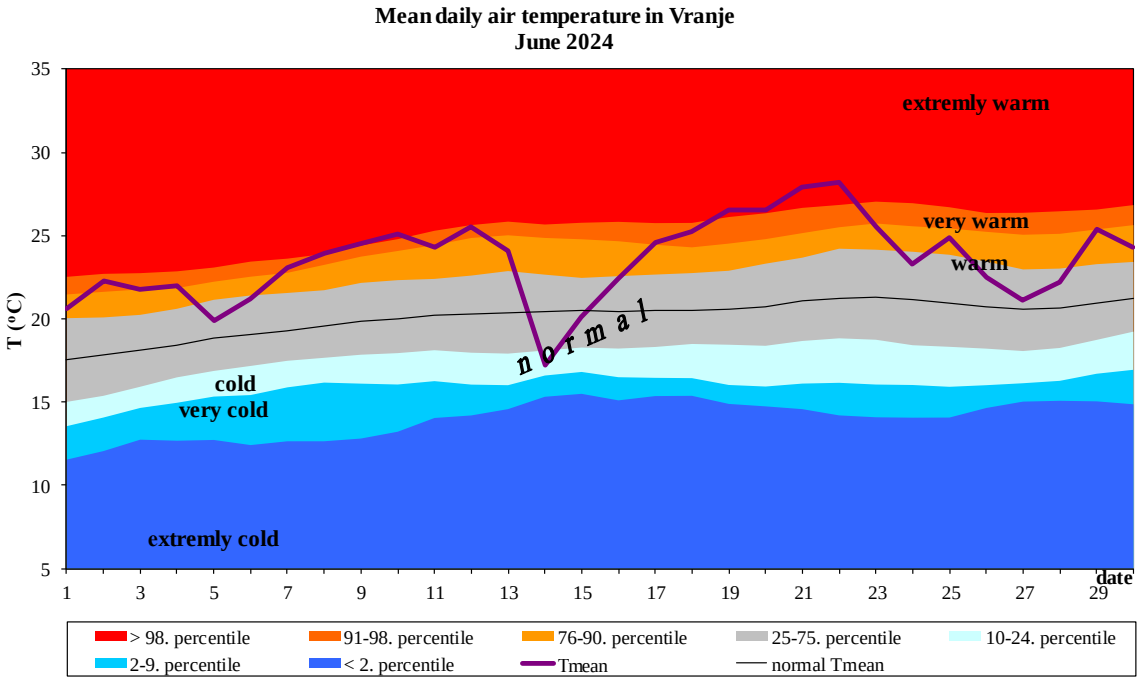
Appendix 14. Daily course of the mean daily air temperature and accompanying percentile for Negotin



Appendix 15. Daily course of the mean daily air temperature and accompanying percentile on Zlatiboru

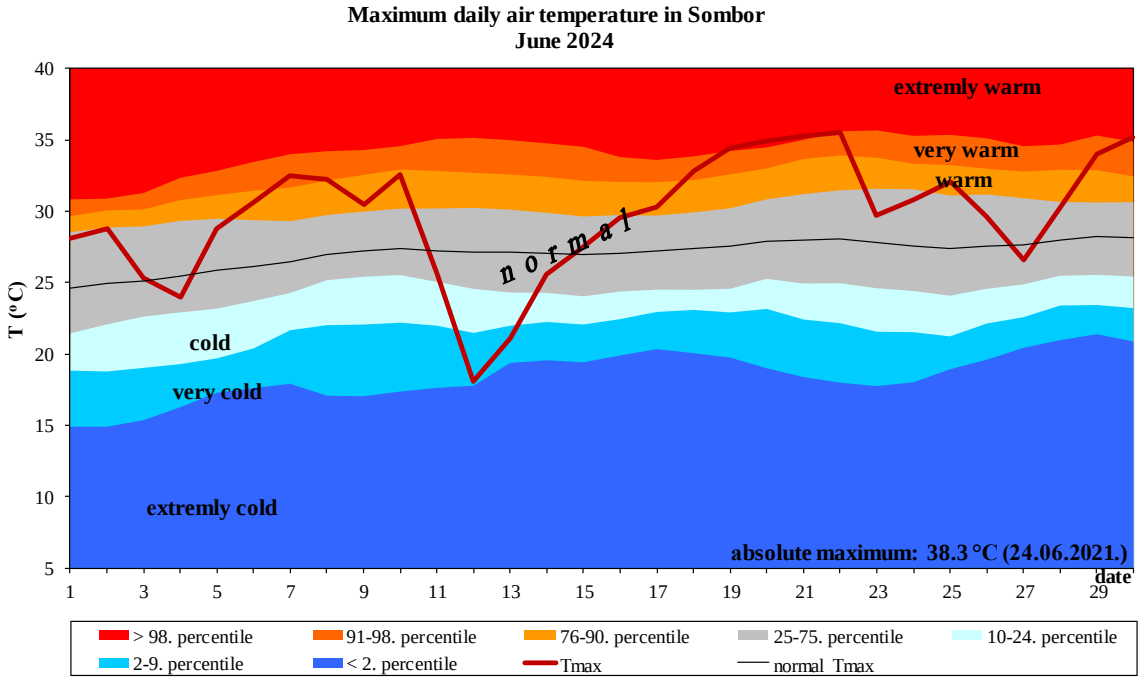


Appendix 16. Daily course of the mean daily air temperature and accompanying percentile for Nis

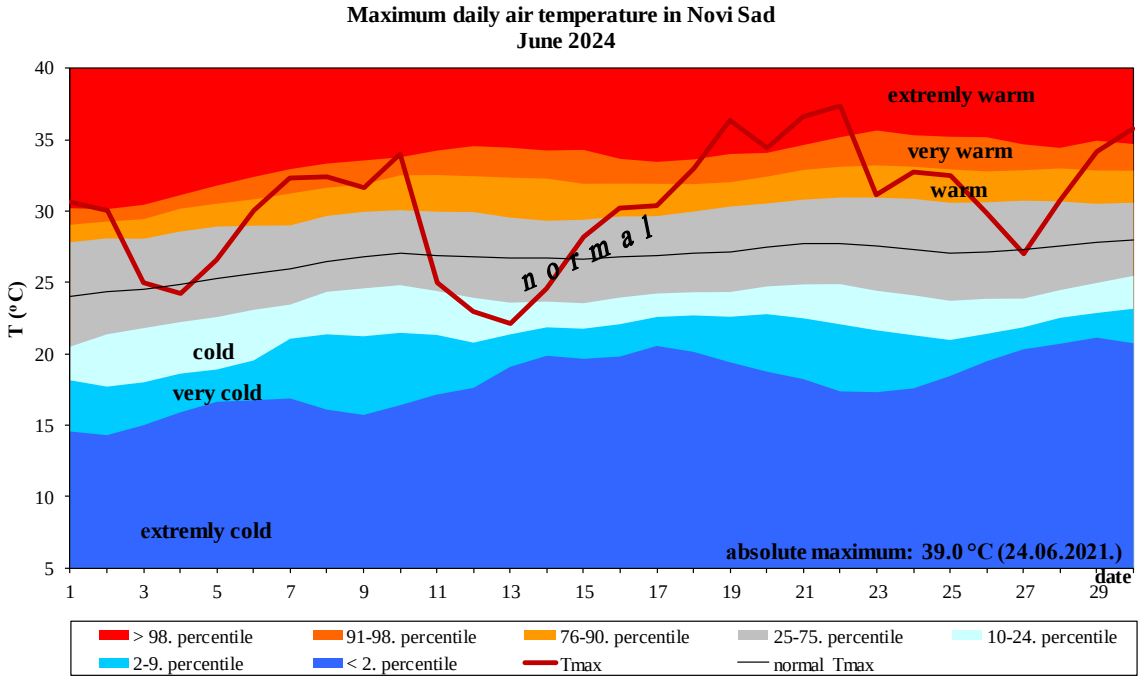


Appendix 17. Daily course of the mean daily air temperature and accompanying percentile for Vranje

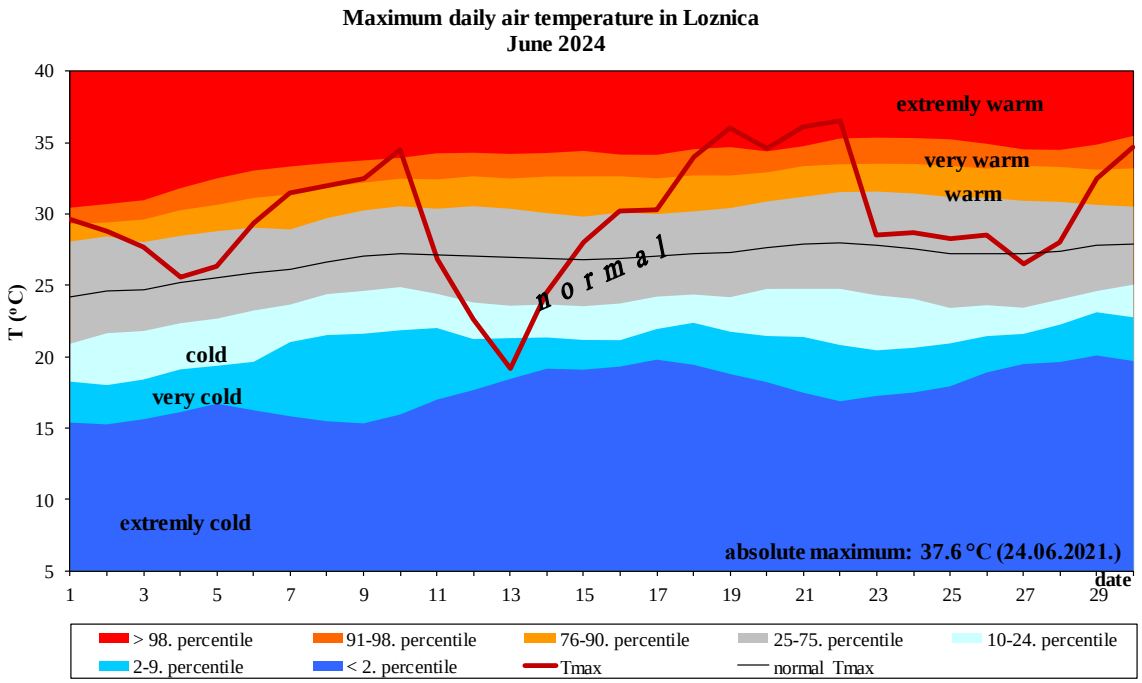
Maximum air temperature



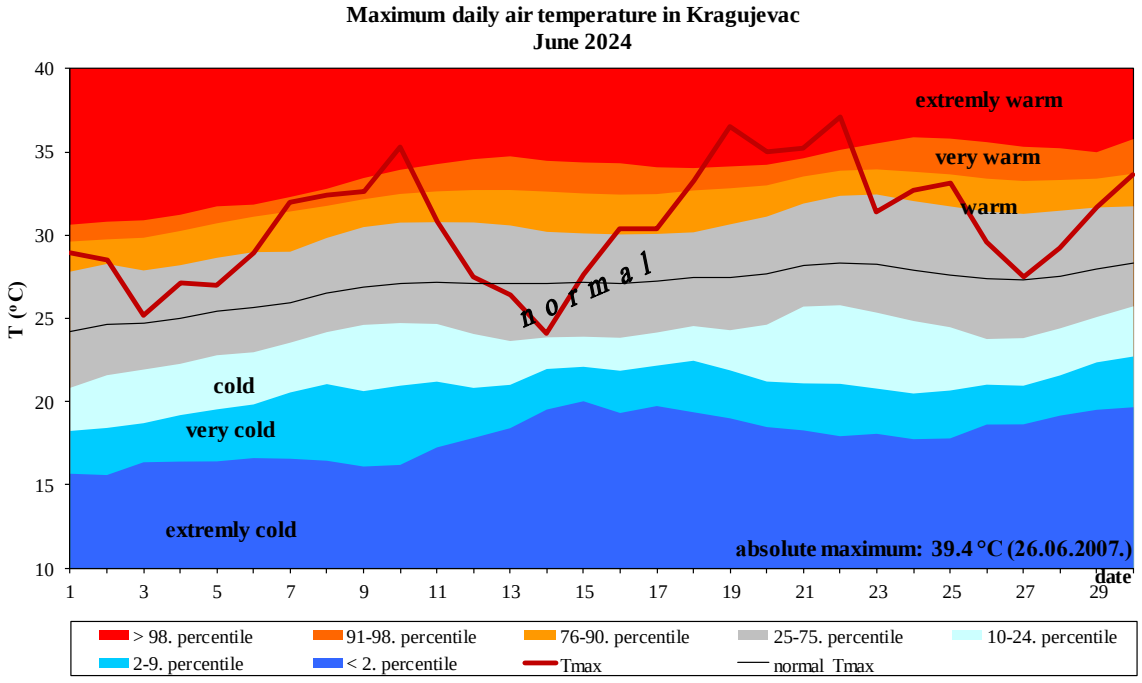
Appendix 18. Daily course of the maximum daily air temeperature and the accompanying percentile for Sombor



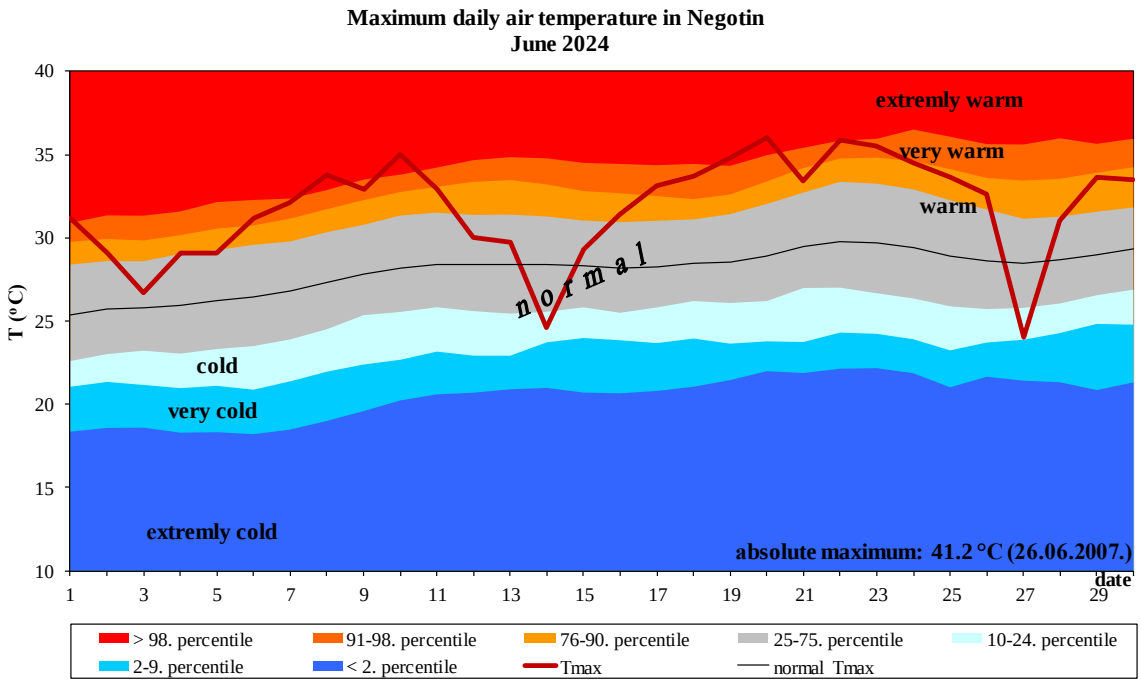
Appendix 19. Daily course of the maximum daily air temeperature and the accompanying percentile for Novi Sad



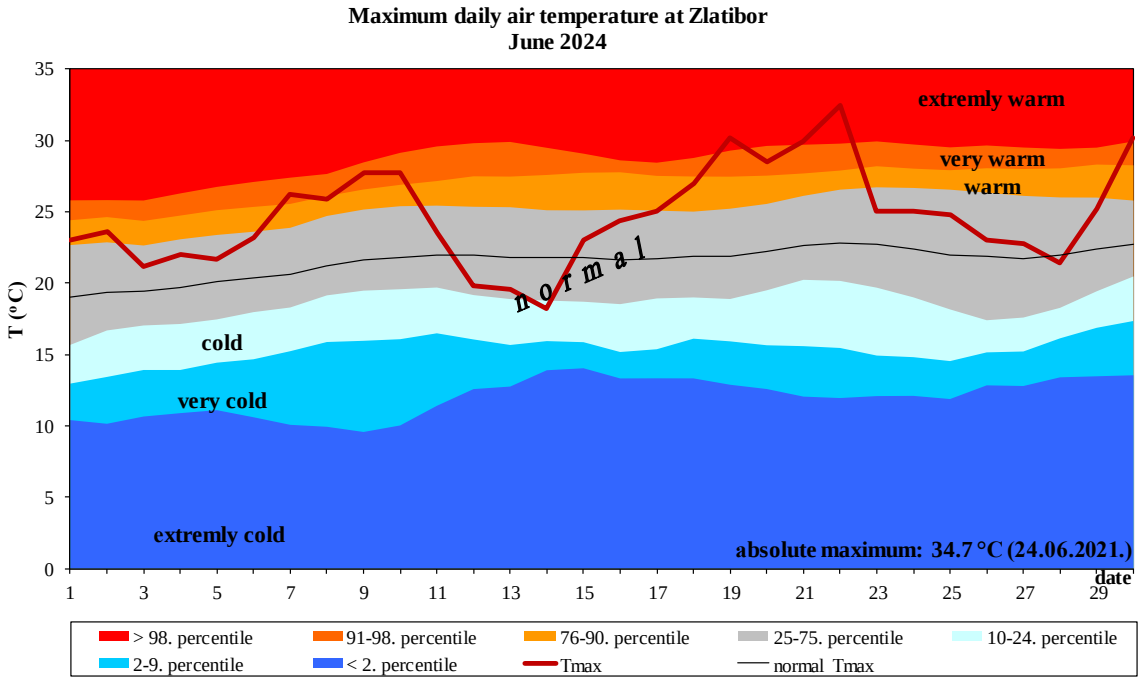
Appendix 20. Daily course of the maximum daily air temeperature and the accompanying percentile for Loznica



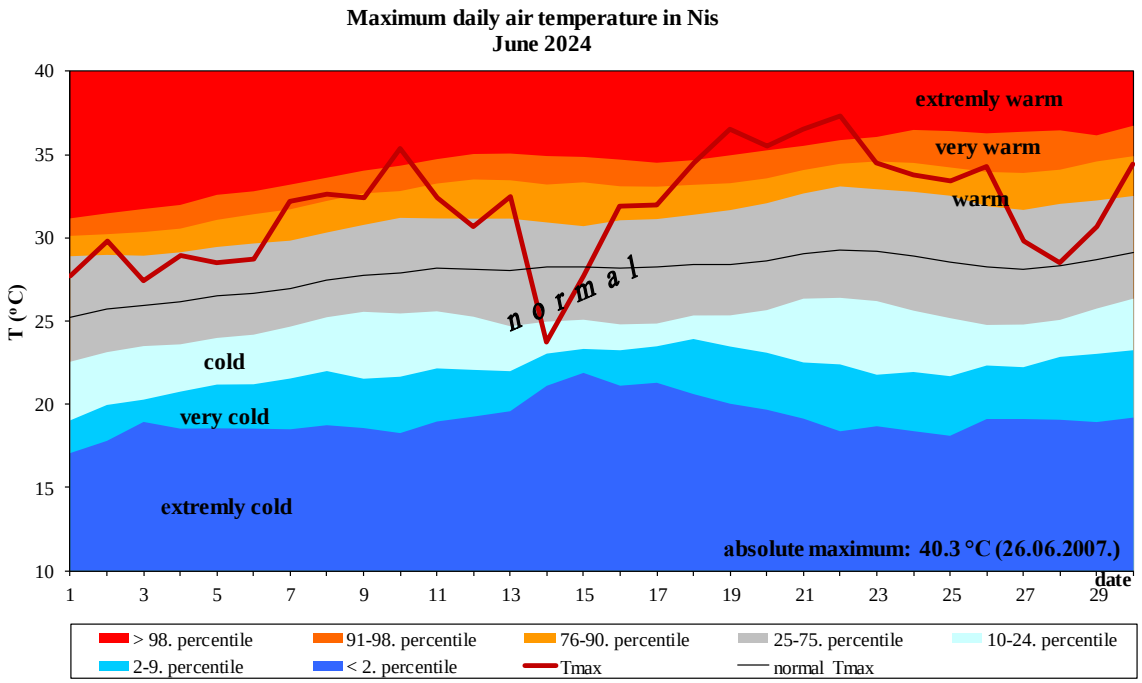
Appendix 21. Daily course of the maximum daily air temeperature and the accompanying percentile for Kragujevac



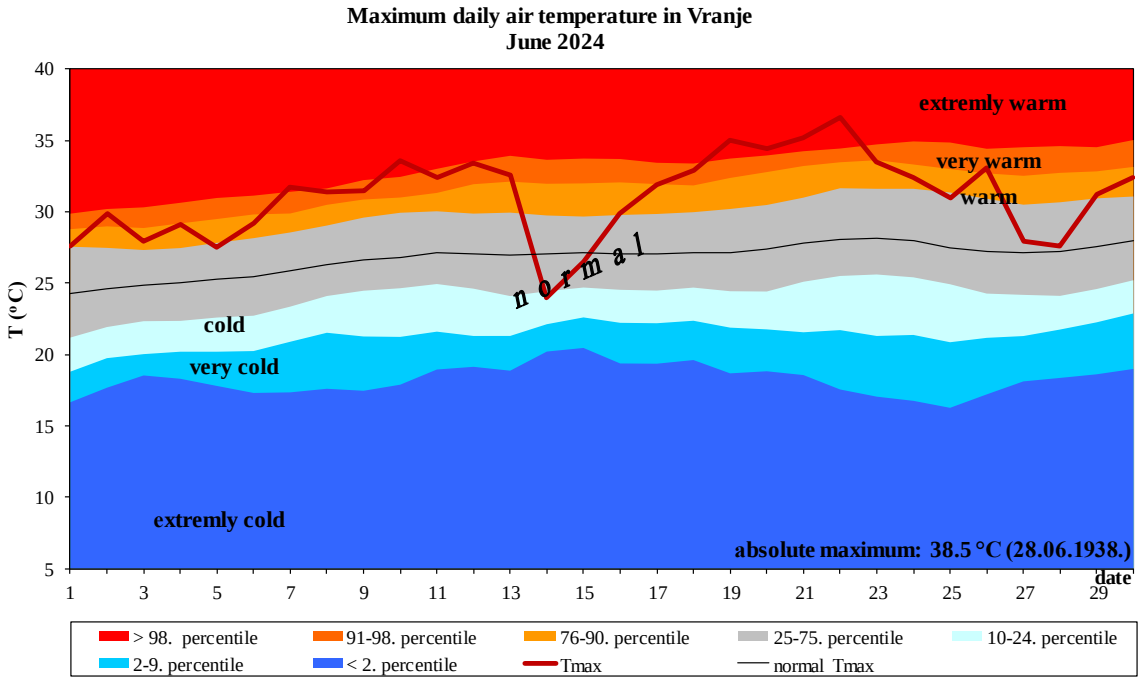
Appendix 22. Daily course of the maximum daily air temeperature and the accompanying percentile for Negotin



Appendix 23. Daily course of the maximum daily air temeperature and the accompanying percentile on Zlatibor

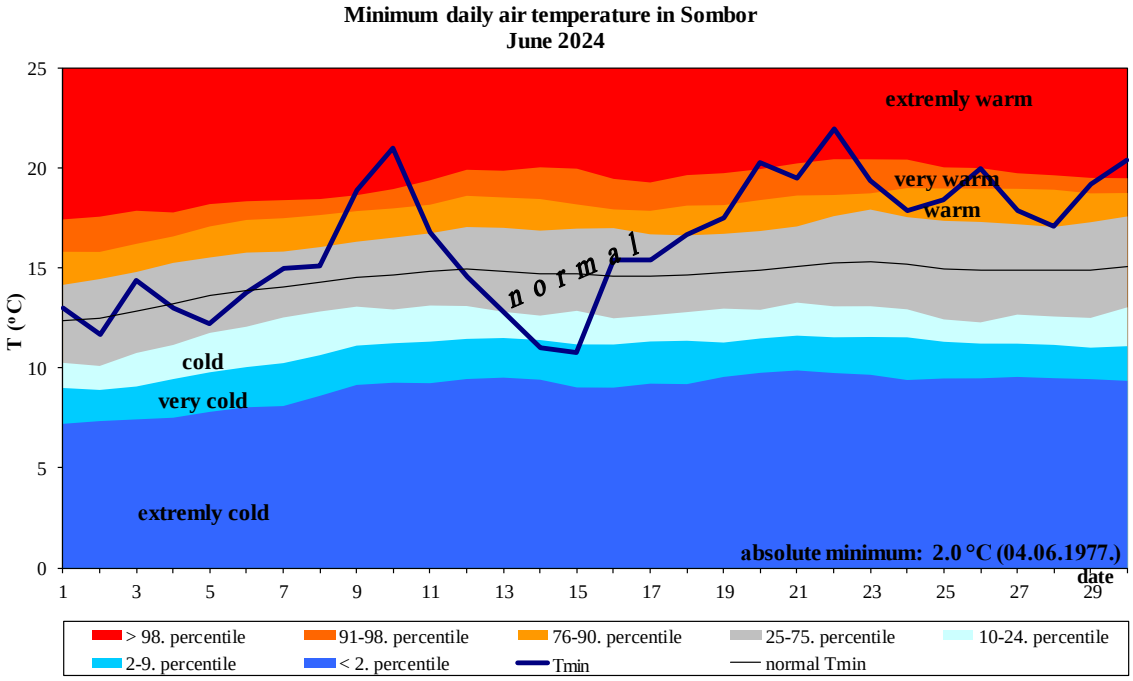


Appendix 24. Daily course of the maximum daily air temeperature and the accompanying percentile for Nis

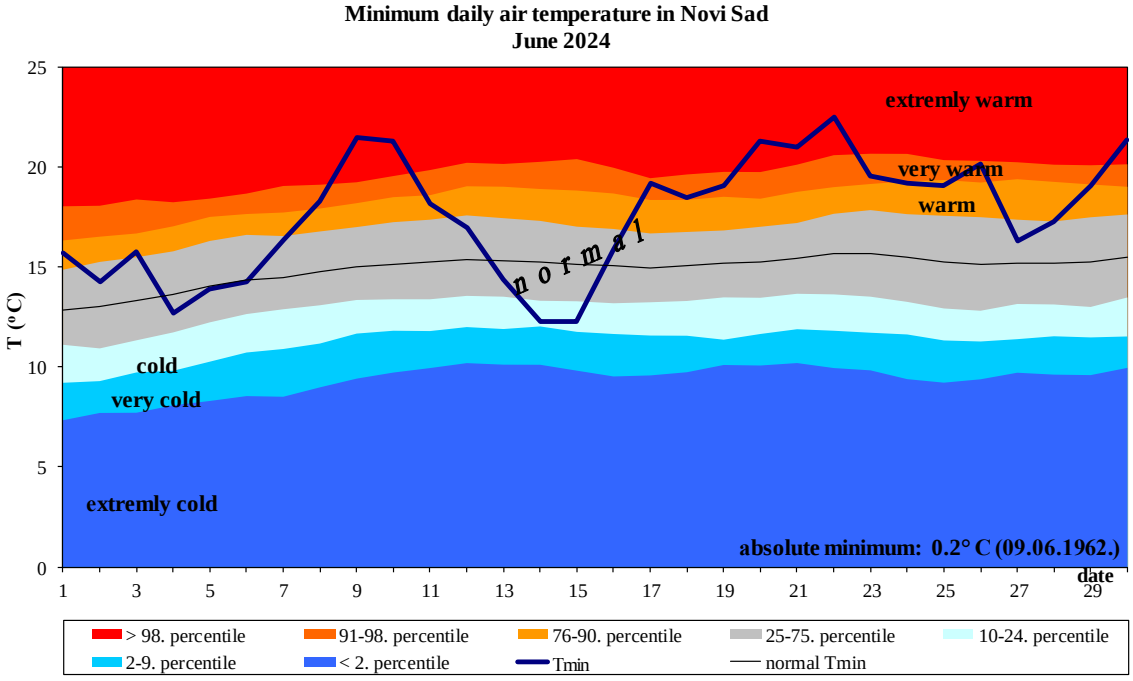


Appendix 25. Daily course of the maximum daily air temeperature and the accompanying percentile for Vranje

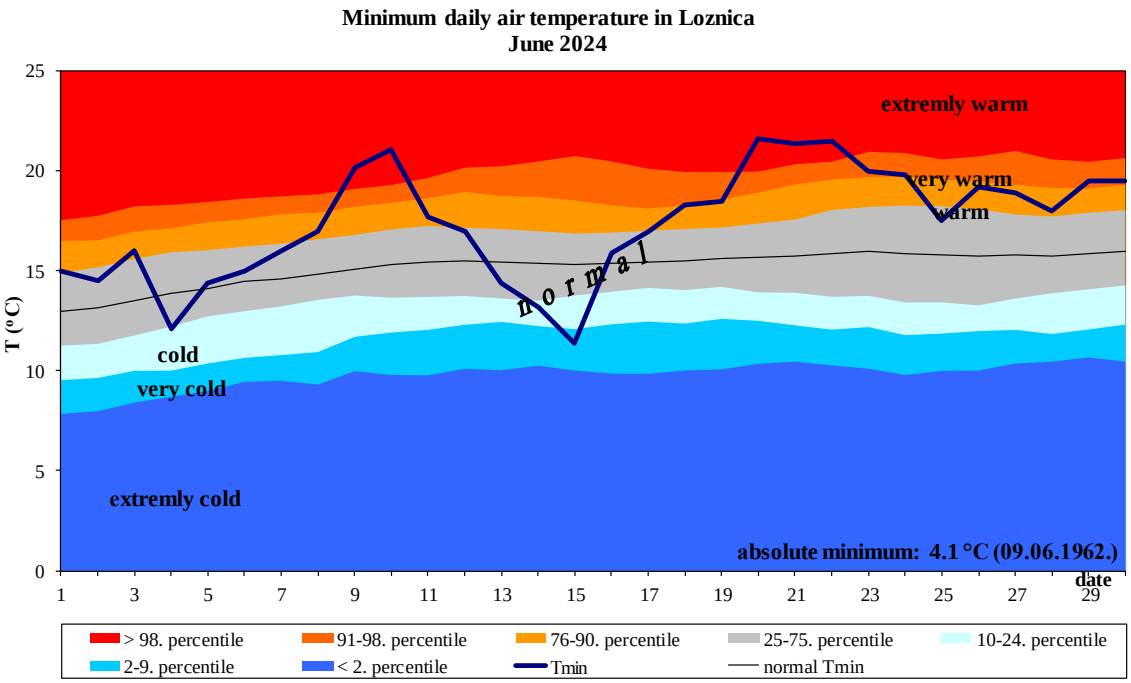
Minimum air temperature



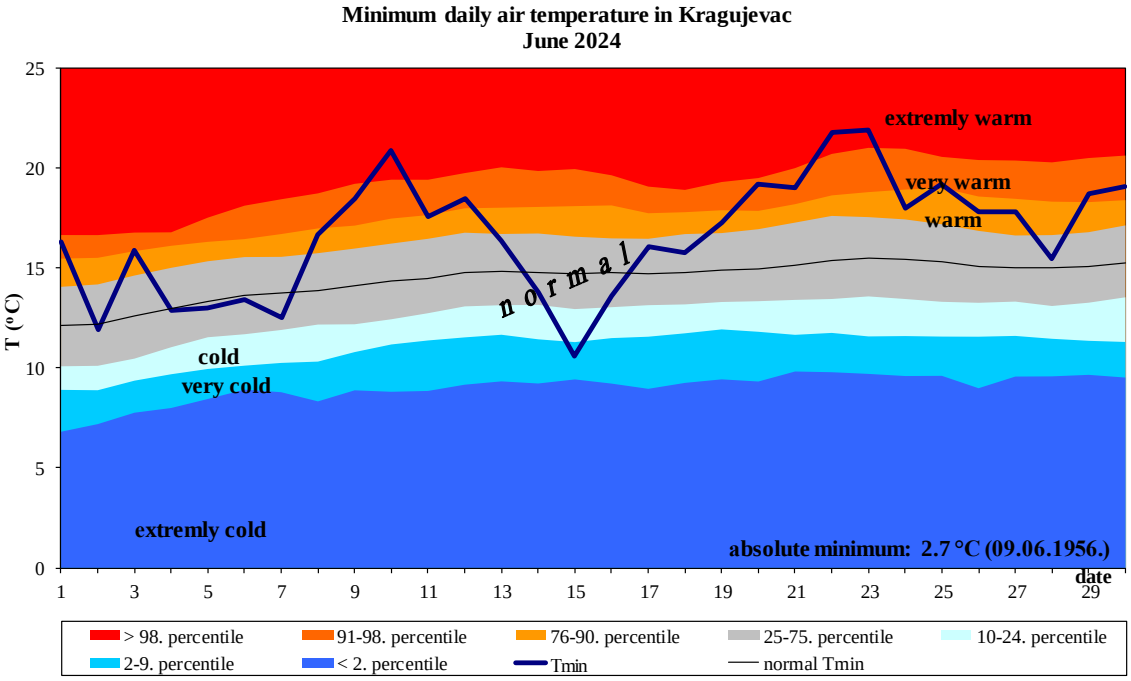
Appendix 26. Daily course of the minimum daily air temperature and the accompanying percentile for Sombor



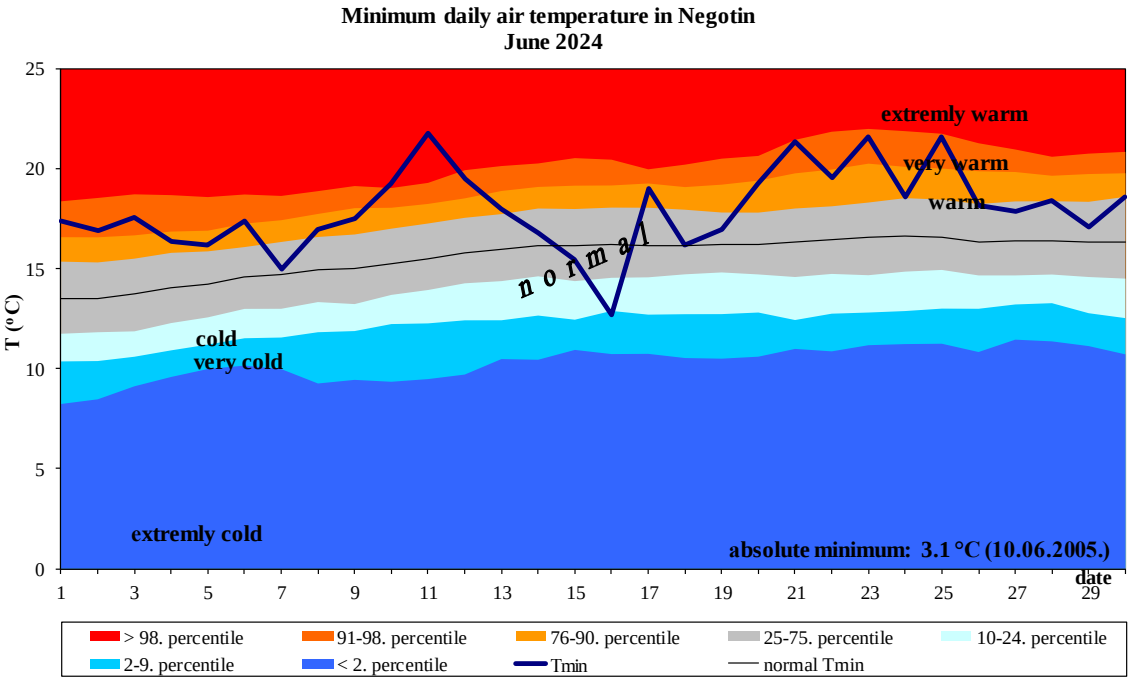
Appendix 27. Daily course of the minimum daily air temperature and the accompanying percentile for Novi Sad



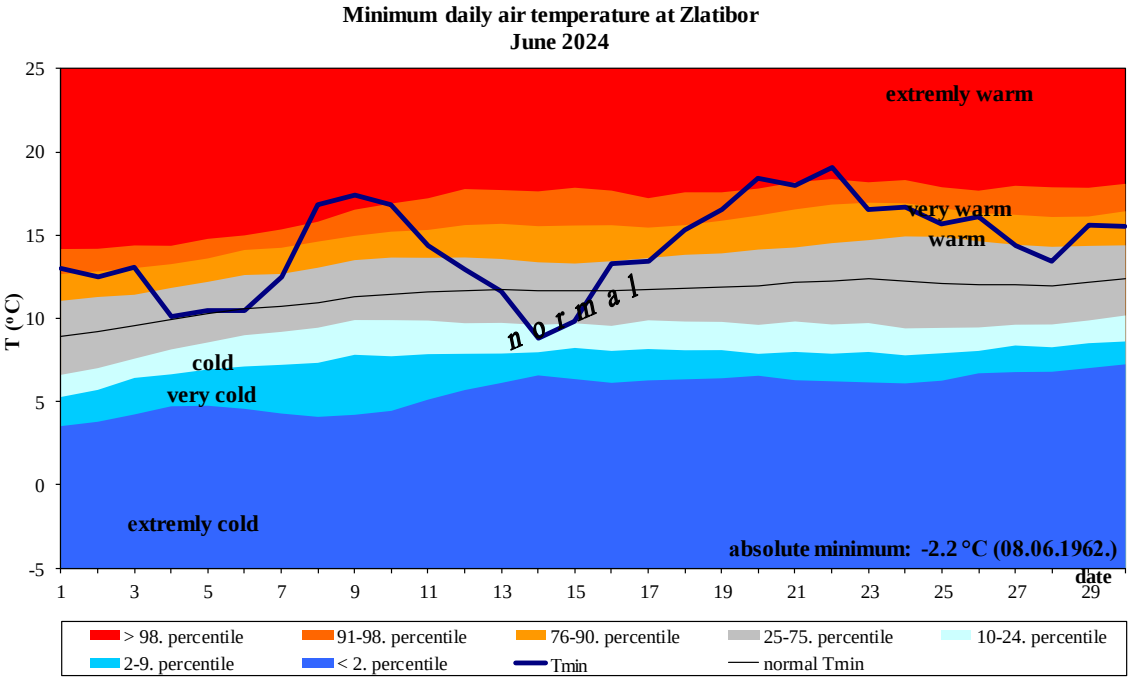
Appendix 28. Daily course of the minimum daily air temperature and the accompanying percentile for Loznica



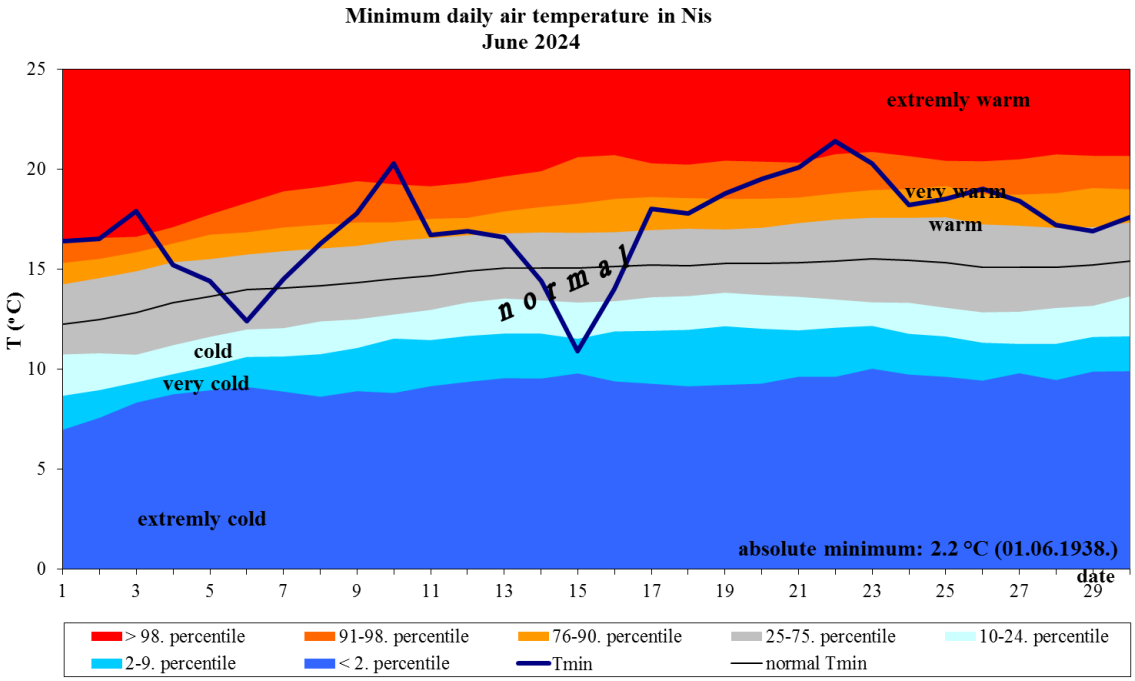
Appendix 29. Daily course of the minimum daily air temperature and the accompanying percentile for Kragujevac



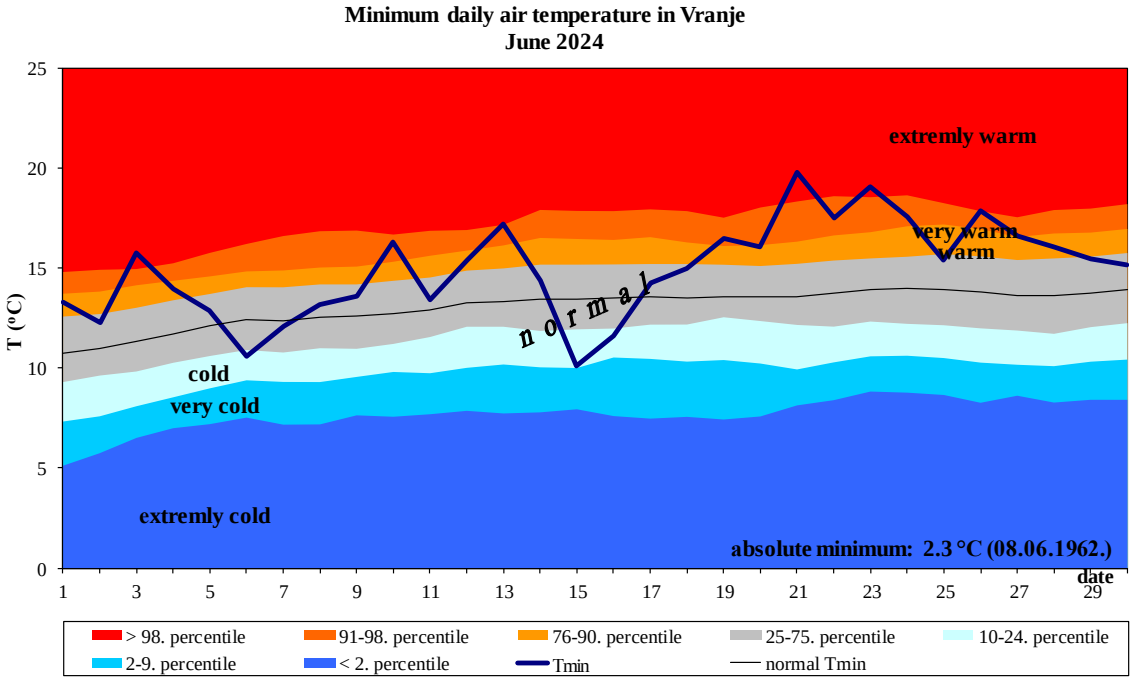
Appendix 30. Daily course of the minimum daily air temperature and the accompanying percentile for Negotin



Appendix 31. Daily course of the minimum daily air temperature and the accompanying percentile on Zlatibor

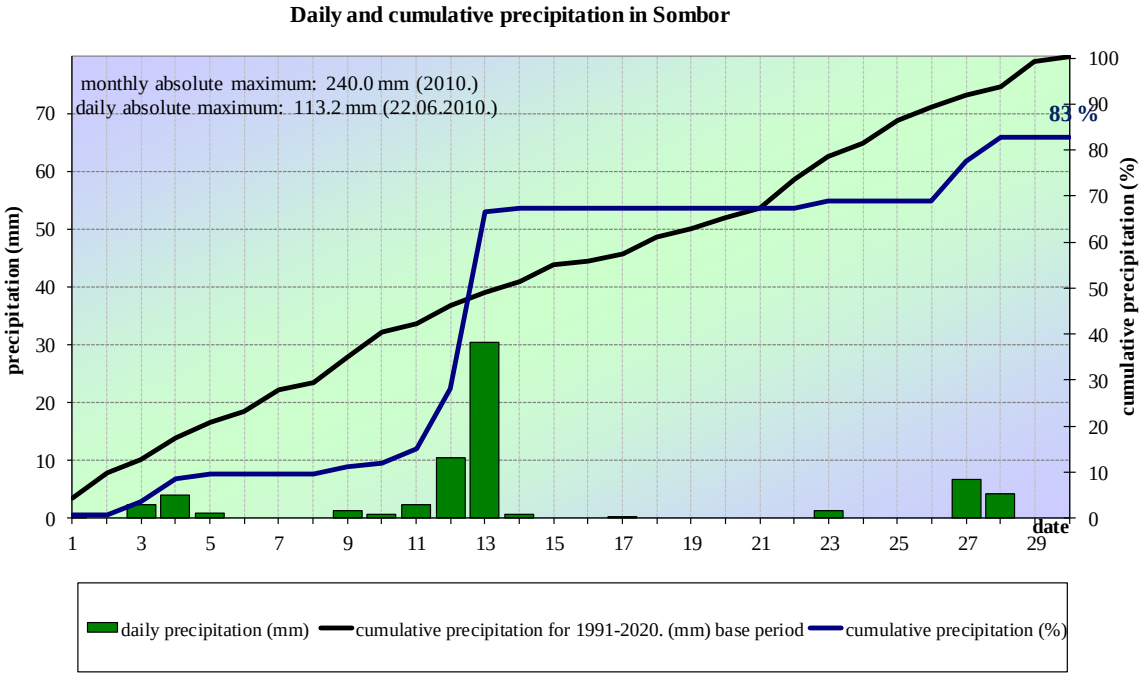


Appendix 32. Daily course of the minimum daily air temperature and the accompanying percentile for Nis

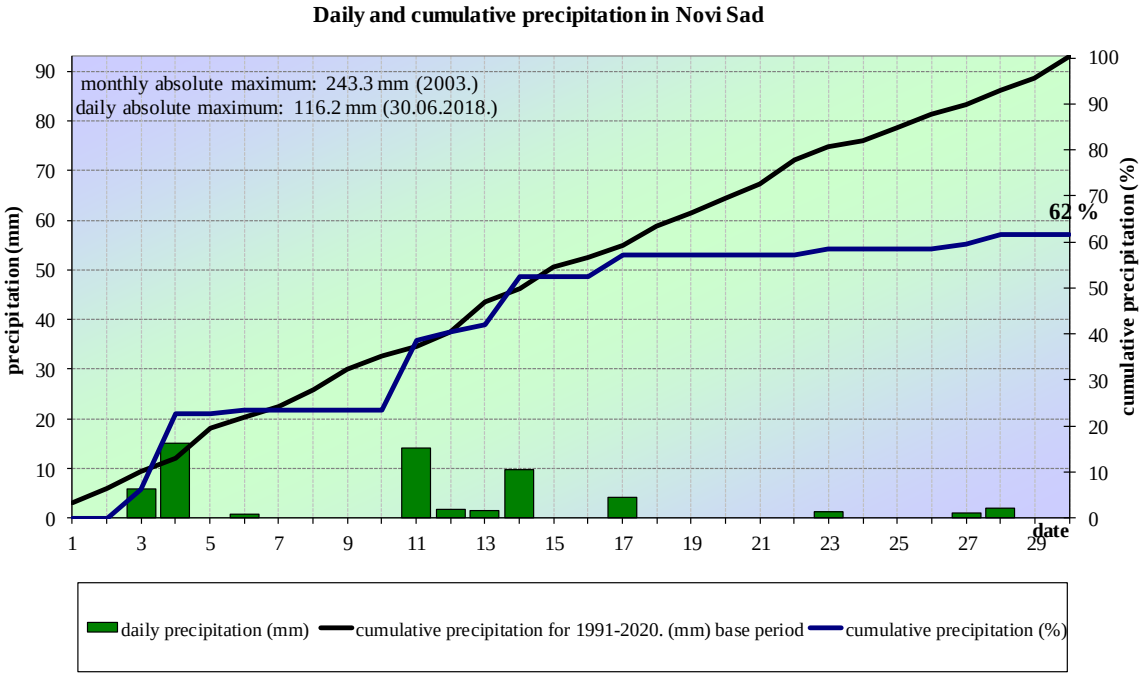


Appendix 33. Daily course of the minimum daily air temperature and the accompanying percentile for Vranje

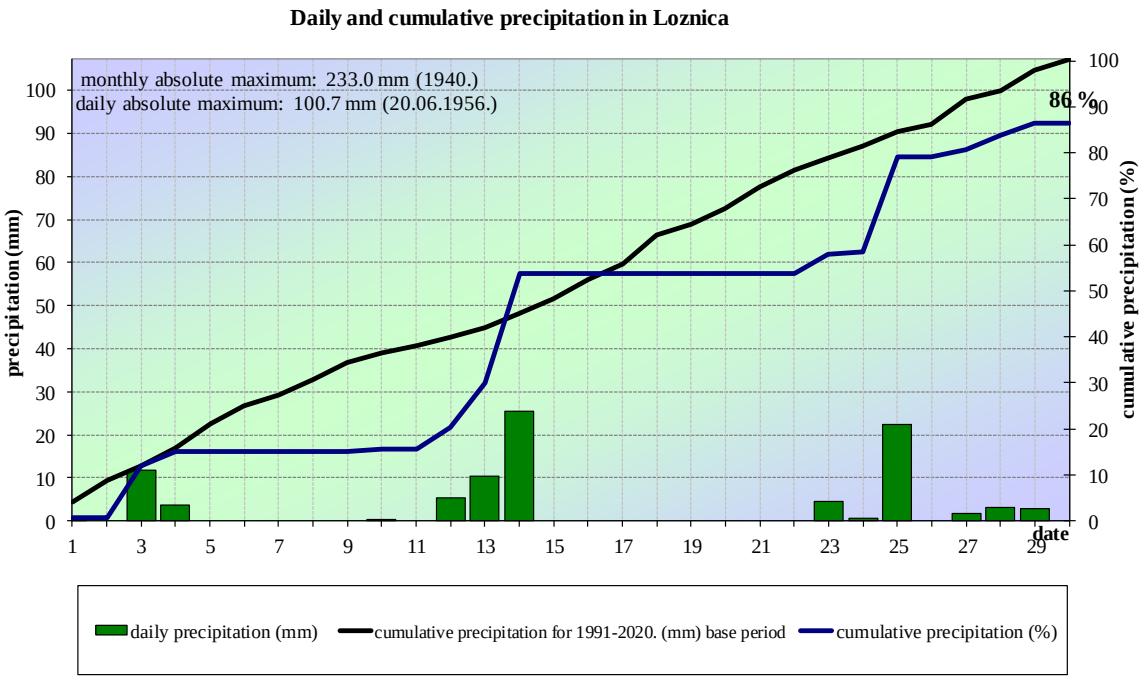
Precipitation



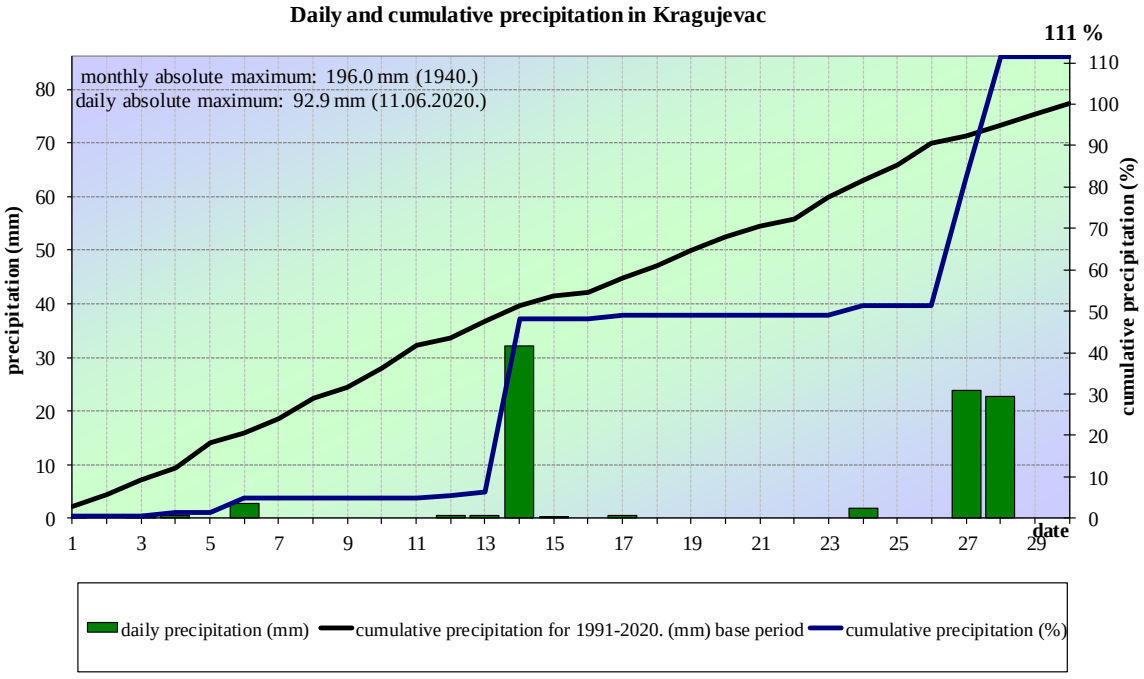
Appendix 34. Daily and cumulative precipitation sums for Sombor



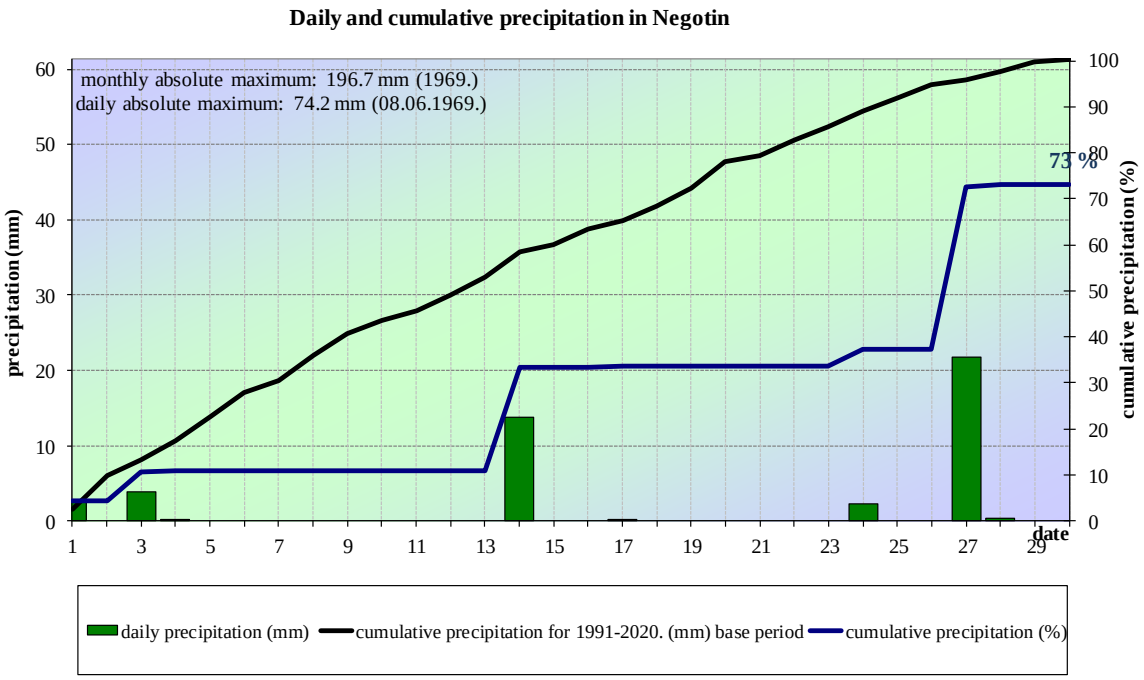
Appendix 35. Daily and cumulative precipitation sums for Novi Sad



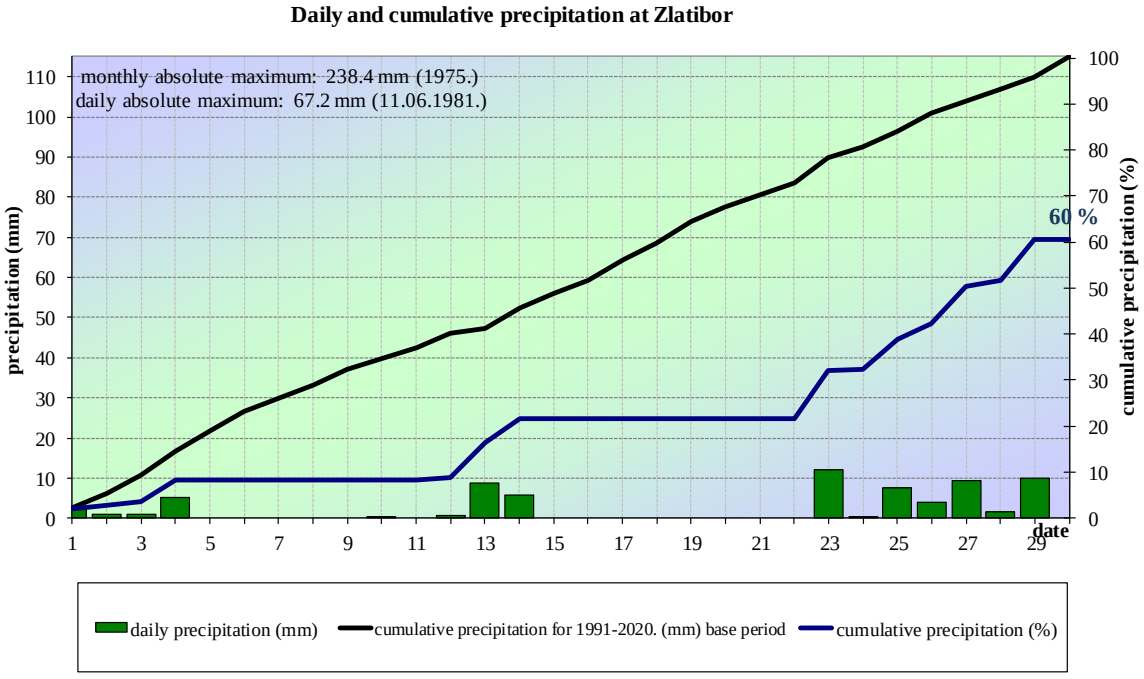
Appendix 36. Daily and cumulative precipitation sums for Loznica



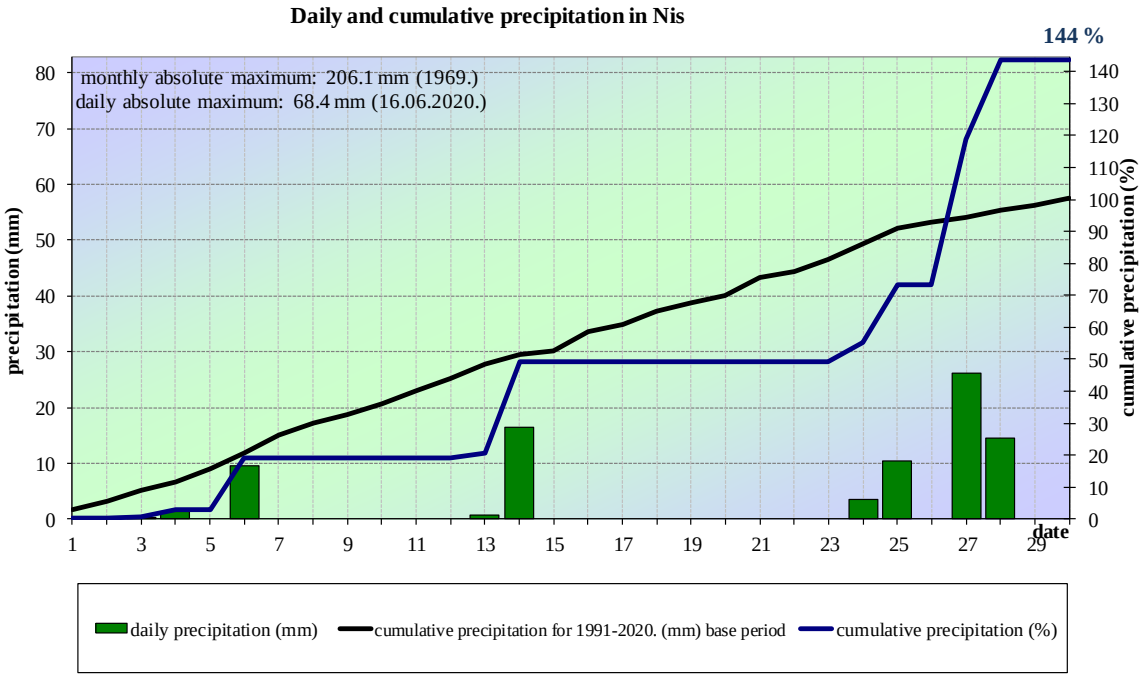
Appendix 37. Daily and cumulative precipitation sums for Kragujevac



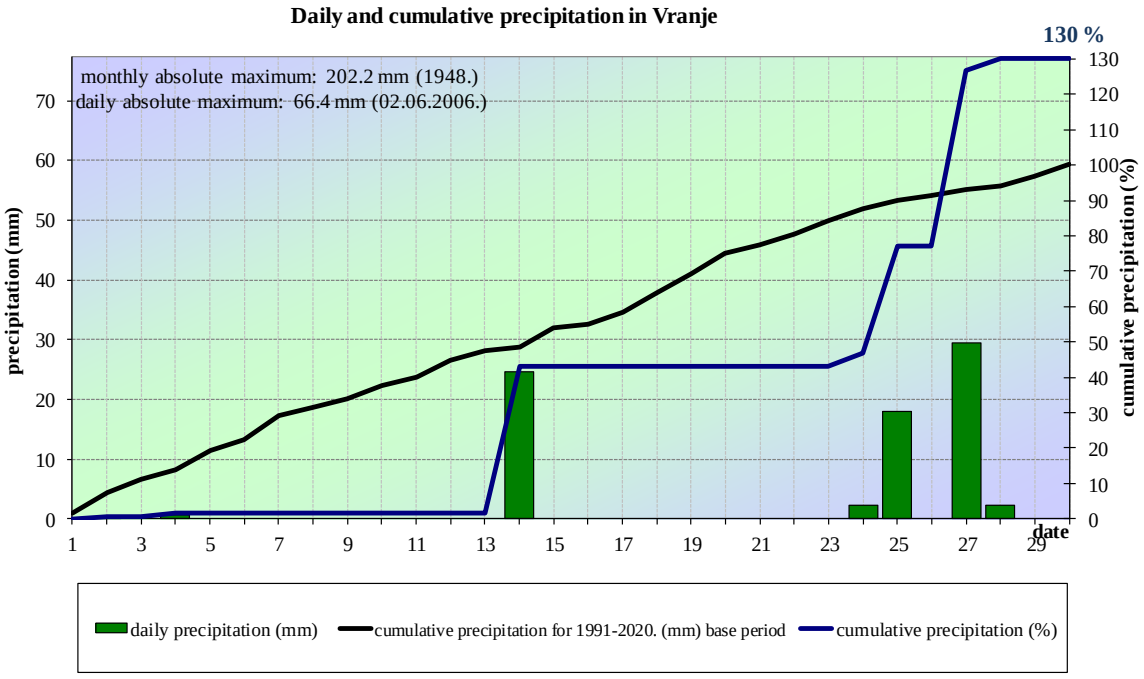
Appendix 38. Daily and cumulative precipitation sums for Negotin



Appendix 39. Daily and cumulative precipitation sums on Zlatibor



Appendix 40. Daily and cumulative precipitation sums for Nis



Appendix 41. Daily and cumulative precipitation sums for Vranje