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SNOW PERIOD IN BELGRADE

Abstract. Snowfall and snow cover are characteristic of the cold part of the year in Serbia. They occur most often in the three winter months (December, January, March), and there are smaller or larger deviations so that they are recorded in the autumn and spring months. Extremely rarely, in some places in Serbia, an extreme case of no snow cover has occurred. In Belgrade, this "miracle" has not yet been recorded in the analyzed period from winter 1921/22 to winter 2024/25. There are data on snow since 1887, when measurements and observations began at the Meteorological Observatory in Belgrade, but data before 1921 were not available for this analysis. Data on the height and number of days with snow cover were analyzed from winter 1986/87 to 2024/25. An analysis of the average date of the first and last snowfalls and snow cover with trends in changes was conducted. The study aims to determine whether there were significant changes in snow parameters. The analyzed data and results are presented in tables and graphs.

Keywords: snowfall and snowcover, middle dates, trends

1. Introduction

The first meteorological instrumental observations and measurements in Belgrade were started on January 1, 1848, by Vladimir Jakšić (1824-1899), a professor at the Lyceum. During his absence, observations were carried out by his friend, Vuk Gavrilović, also a professor at the Lyceum, and in the last year (1899) by members of his immediate family. The measuring site was on Jakšić's private estate in Senjak, then a suburb of Belgrade. The period of Jakšić's observations from August 1, 1887 to December 31, 1899 coincides with the systematic measurements and observations at the Velika škola Observatory that were started by Professor Milan Nedeljković (1857-1951), first in a private house (from August 1, 1887 to May 1, 1891), near the newly built building in Zapadni Vračar, which is also the current location of the Meteorological Observatory (44.48o N, 20.28○ E, 131.6 m asl). Data on snow and snow cover were recorded at all locations, however, there are breaks in homogeneity, primarily during the war years. Snow data from 1887-1985. were processed and published in publications [1] and [2] of the Republic Hydrometeorological Service of Serbia. For the analysis in this paper, data on snow cover from the winter of 1921/22 to the winter of 2024/25 [3] were used, and data on snowfall and the dates of their first and last appearance from 1985/86 to 2024/25

2. Methodology

The development of the city has somewhat changed the surroundings of the Meteorological Observatory; in the late nineteenth and early twentieth centuries, it was on the periphery, while today it is in the central part of the city. Parts of the city on the left side of the Sava and Danube rivers are located in the plain area at an altitude of 70-100 m asl, and parts south of the central ones are in the hilly area with altitudes of up to

335 m asl (Kumodraž). The expansion of the city area, the increase in roads, industrial facilities, and residents has caused the inner city area to become a "heat island". This fact and the orography cause small but noticeable differences in the values of meteorological parameters between individual parts of the city, which is also reflected in snowfall and the height of the snow cover. Here, microclimatic differences in the city area are not analyzed, but only data from the Meteorological Observatory in Vračar, which over time has been located in the central parts of the city. In addition, it is normal for the snow cover, by its nature of formation, to differ in height values during the day. Due to the homogeneity of the series, measurement data at 07:00 (UTC+1) were taken for the analysis of the height of the snow cover, with a criterion of a minimum height of 1 cm. Cases when there was snow on the ground in traces were not taken for analysis.

3. Analysis and results

A basic analysis was performed, and the results are presented in tabular and graphical form. Figure 1 shows the basic data on the number of days and the height of the snow cover graphically. All parameters have a decreasing trend. However, the coefficients of determination (R^2) indicate that these changes are not significant (Table 1). The decreasing trend can be partly associated with the increase in temperature at the global level and partly due to the change in microclimatic conditions due to urbanization and the strengthening of the urban heat island. Previous analyses of extreme meteorological parameters in the period 1888-2023 [4] show that the trend of change for most of them is not statistically significant (absolute annual maximum temperature, number of days with Tmax ≥ 35°C, number of days with Tmax ≥ 37°C, minimum and maximum monthly precipitation, maximum daily and monthly precipitation, number of days with precipitation ≥ 30 mm, annual precipitation total, number of days with thunderstorms, number of days with snow cover, annual maximum snow depth and number of days with snow cover ≥ 10 cm). The decreasing and increasing trends within the analyzed period represent periodic fluctuations and are not indicators of climate change. A moderate decreasing trend exists only in three of the sixteen analyzed parameters: annual maximum wind speed (r=0.667), annual number of days with minimum air temperature 5°C below zero (r=0.606), and 10°C below zero (r=0.504), where r is the correlation coefficient. The absolute annual minimum air temperature has a moderate increasing trend (r=0.4688) [4]. An analysis of the temperature in the Belgrade region for the period 1988-2014 [5] found a difference in temperature between the central parts of the city and the surrounding area. The temperature difference was positive throughout the entire analysis period, i.e., the average annual temperature is higher in the city than in the countryside. The largest difference was in 2006 (0.88 °C), and the smallest in 2000 (0.46 °C). The difference has an increasing trend, but without statistical significance.

Figure 1 (bottom right) shows the sum of all daily snow cover heights for each date. The goal was to see on which date and in which periods snow cover occurs most frequently. From the beginning of December, the sum of heights increases rapidly, which coincides with the average date of the first snow cover (December 5). Then, a maximum is observed in mid-December and a main period lasting approximately 40 days (January 10 - February 20) after which the sum decreases rapidly, which coincides with the average date of the last snow cover (March 5).

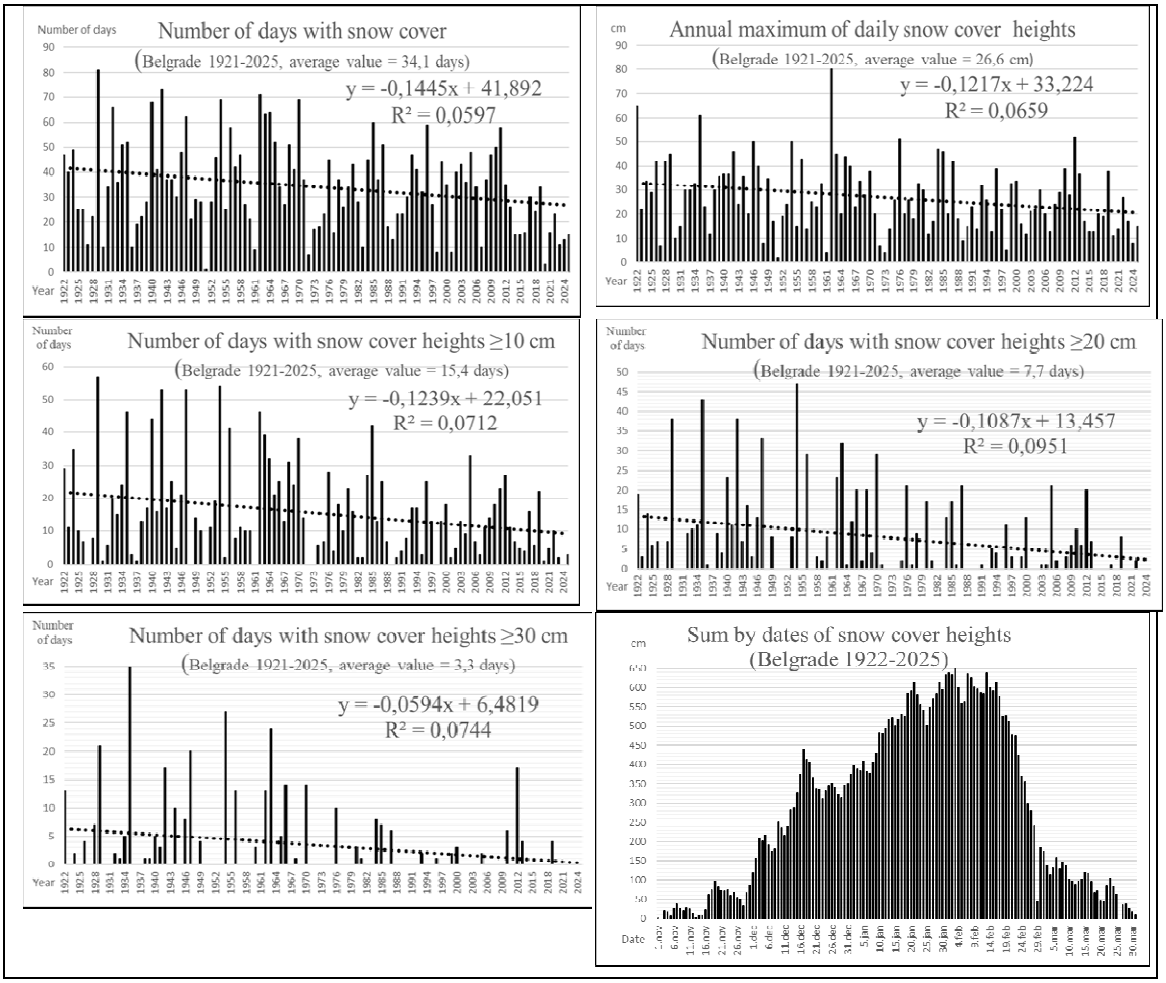

Figure 1. Parameters of snow cover heights in 1921/22-2024/25.

Table 1.Trends of snow cover heights in 1921/22-2024/25.

Number of days with snow cover	Y= -0,1445x + 41,892 R^2= 0,0597
Annual maximum of daily snow cover heights	Y= -0,1217x + 33,224 R^2= 0,0659
Number of days with snow cover heights > 10 cm	Y= -0,1239x + 22,051 R^2= 0,0712
Number of days with snow cover heights > 20 cm	Y= -0,1087x + 13,457 R^2= 0,0951
Number of days with snow cover heights > 30 cm	Y= -0,0594x + 6,4819 R^2= 0,0744

Winter with the highest snow cover: 80 cm, February 2, 1962.

Winter with the lowest snow cover height and duration: 2 cm, January 19, 1951. (duration 1 day).

Table 2. Middle dates of first and last snowfall and snow cover, and ordinal number of the date in 1986-2025.

	First snowfall		First snow cover		Last snowfall		Last snow cover	
Year	Date	Day	Date	Day	Date	Day	Date	Day
1986	19.12.	353	28.12.	362	20.03.	79	07.03.	66
1987	08.12.	342	08.12.	342	16.03.	75	13,03	72
1988	01.11.	306	05.11.	310	16.04.	107	13.03.	73
1989	23.11.	327	28.12.	362	15.02.	46	15.02.	46
1990	01.12.	335	01.12.	335	17.02.	48	14.02.	45
1991	06.12.	340	21.12.	355	16.02.	47	17.02.	48
1992	07.12.	342	28.12.	363	18.04.	109	18.04.	109
1993	13.11.	317	13.11.	318	31.03.	90	31.03.	90
1994	30.11.	334	21.12.	356	20.02.	51	24.02.	55
1995	04.11.	308	04.11.	308	12.04.	102	15.03.	74
1996	24.11.	328	03.12.	338	16.04.	107	14.04.	105
1997	18.11.	322	19.11.	323	22.04.	112	22.04.	112
1998	18.11.	322	20.11.	325	22.03.	81	02.02.	33
1999	19.11.	323	22.11.	327	21.03.	80	18.02.	49
2000	19.12.	354	22.01.	387	20.03.	80	19.03.	79
2001	19.11.	323	29.11.	333	28.03.	87	01.03.	60
2002	07.11.	311	17.12.	351	07.04.	97	22.01.	53
2003	06.12.	340	17.12.	351	08.04.	98	15.03.	74
2004	14.11.	319	15.11.	320	10.03.	70	06.03.	66
2005	19.11.	323	21.11.	325	19.03.	78	13.03.	72
2006	03.11.	307	03.11.	337	07.04.	97	17.03.	76
2007	17.11.	321	17.11.	321	04.02.	35	28.01.	28
2008	22.11.	327	26.11.	331	25.03.	85	17.02.	48
2009	03.11.	307	03.11.	308	21.03.	80	01.03.	60
2010	01.12.	335	09.12.	343	13.03.	72	14.03.	73
2011	30.11.	334	17.01.	382	07.03.	66	09.03.	68
2012	03.12.	337	08.12.	343	28.02.	59	26.02.	57
2013	26.11.	330	27.11.	331	01.04.	91	28.03.	87
2014	28.11.	332	28.12.	362	29.01.	29	03.02.	34
2015	22.11.	326	22.11.	326	06.03.	65	10,02	41
2016	13.11.	318	03.01.	368	05.02.	36	25.01.	25
2017	26.11.	330	03.12.	337	20.04.	110	01.02.	32
2018	18.11.	322	28.11.	332	26.03.	85	25.03.	84
2019	28.12.	362	27.02.	423	23.02.	54	01.02.	32
2020	30.11.	335	09.01.	375	25.03.	85	25,03	85
2021	07.12.	341	12.12.	346	07.04.	97	07.04.	97
2022	12.12.	346	12.12.	346	10.03.	69	08.03.	67
2023	26.11.	330	06.12.	340	05.04.	95	06.04.	96
2024	20.11.	325	22.11.	327	23.01.	23	23.01.	23
2025					07.04.	97	15.02.	46
Mean	26.11.	329,077	09.12.	342,795	18.03.	76,850	05.03.	63,500

In recent decades, the public has noticed that winters are milder and with less snow. This is attributed to climate change, primarily the increase in temperature, and such an opinion is somewhat encouraged by the prevailing hypothesis in expert circles that the climate is changing due to human activity and greenhouse gas emissions. In essence, trends in changes in climate factors over a very short period, such as a decade,

are not a reliable indicator. Even a decade is a very short period for determining significant changes in microclimatic characteristics. In the series of snow data for 1888-2025, there are decades when there was more snow and those when there was less. We present a comparison of two decades, the first (2015/16-2024/25) and the second (1995/96-2004/05). In the first decade, there were an average of 18.5 days with snow cover, of which 6.9 days with a snow cover height of more than 10 cm, and in the second, an average of 34.8 days, of which 13 with a height of more than 10 cm. Otherwise, for 1921/22 – 2024/25, the average number of days with snow cover is 34.1, of which 15.4 days with a height of more than 10 cm. A good indicator of the characteristics of winter is also the average dates of the appearance of the first and last snow and snow cover. In the first case, these are the following dates in order: November 29, December 18, February 28, and March 16, and in the second, the following dates: November 22, December 04, March 11, and March 30. These dates show that in the first analyzed decade, the snow period is shortened, and in the second, it is extended by about the values of these parameters for the entire period. Due to the unavailability of these parameters for 1888-1985, it was not possible to provide similar examples. Otherwise, both compared decades are in a longer period of about 40 years, in which there is an increase in temperature at the global level. A similar assessment of the trend at the decadal level is also valid for longer periods. This last multi-decadal period is similar to the first half of the twentieth century, and between them, there is a multi-decadal period with a slight trend of decreasing global temperature, and the data for Belgrade fit into this dynamics.

Table 2 provides data on the dates of the appearance of the first and last snow and snow cover for each year in the period 1986-2025. and finally, the mean dates for the entire analyzed period. Table 3shows the trends in mean dates for 1986-2025. It is observed that the period of snow and snow cover occurrence is shortening, but the trends are not statistically significant. Table 4 shows the mean dates of the first and last occurrence of snow and snow cover for two periods (1887-1962, 1887-1985) published in the “Observation Results” [1] and [2], then for the period 1985-2025 and finally the mean dates calculated and reduced to the values for the period 1887-2025. The mean dates for the entire period do not have significant shifts, or are the same or very close to the values from 1887-1962. In other words, the duration of the snowy period in Belgrade has not changed substantially for more than a century. Table 5 shows the extreme values of the earliest and latest dates with snowfall and snow cover.

Table 3. Trends of middle dates in 1986-2025.

First snowfall	$Y= 0,096x + 327,16 \quad R^2= 0,007$
First snow cover	$Y= 0,3354x + 336,09 \quad R^2= 0,0263$
Last snowfall	$Y= -0,2619x + 82,219 \quad R^2= 0,0165$
Last snow cover	$Y= -0,3771x + 71,231 \quad R^2= 0,0344$

Table 4. Middle dates of first and last snowfall and snow cover in 1887-2025.

	First snowfall		First snow cover.		Last snow cover		Last snowfall	
Period	Date	Day	Date	Day	Date	Day	Date	Day
1887-1962	23.11.	327	05.12.	339	05.03.	64	21.03.	80
1887-1985	23.11.	327	03.12.	337	05.03.	64	21.03.	80
1986-2025	26.11.	329,077	09.12.	342,795	05.03.	63,5	18.03.	76,85
1887-2025	21.11.	325,204	05.12.	338,649	05.03.	63,855	20.03.	79,087

Table 5. Extreme dates of first and last snowfall and snow cover (1887-2025). Source [1] and [2] with updates until 2025.

Snowfall		Date	Snow cover		Date
First	earliest	07.10.1897.	First	earliest	20.10.1908.
	latest	05.01.2021.		latest	27.02.2020.
Last	earliest	01.02.1972.	Last	earliest	12.11.1912.
	latest	11.05.1953.		latest	22.04.1997.

4. Conclusion

In 1887-2015, there was no winter without snowfall and snow cover at the Belgrade Meteorological Observatory. Each winter was specific, differing from the other in the number of days with snowfall and snow cover, its height, and the dates of the first and last appearance. The series of these parameters has a decreasing trend, but it is not statistically significant. The characteristics of the snow period in Belgrade have not changed significantly for more than a century. The average duration is 120 days, from November 21 to March 20.

References

[1] Results of observations at the Meteorological Observatory in Belgrade in 1887-1962. Republic Hydrometeorological Service of Serbia, Belgrade,1962.
[2] Results of observations at the Meteorological Observatory in Belgrade in 1887-1985. Republic Hydrometeorological Service of Serbia, Belgrade,1985.
[3] Meteorological data. Republic Hydrometeorological Service of Serbia.
[4] Todorović N.: Trends of extreme values of meteorological phenomena in Belgrade. Collection of abstracts of the conference "Security of infrastructure systems", Belgrade, 2023.
[5] Vujović D., Todorović N, Urban/rural fog differences in the Belgrade area, Serbia, Theor. Appl. Climatol., 131(2018), 889–898 (DOI:10.1007/s00704-016-2019-z), M22.

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