

CHANGEABILITY OF AVERAGE VALUES OF DAILY ABSOLUTE MINIMUM, MAXIMUM, AND MEAN AIR TEMPERATURE FOR EACH MONTH OF THE YEAR IN BAKU AND TBILISI IN 2005-2024

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Abstract. Results of statistical analysis of average values of daily absolute minimum ($T_{\min}$), maximum ($T_{\max}$), Daily Temperature Range (DTR) and mean (T_{mean}) air temperature for each month of the year in Baku and Tbilisi in 2005-2024 and their variability in 2020-2024 (second period) compared to 2005-2009 (first period) are presented.

It is shown that against the background of rapid climate warming over the past two decades, in the second period of the selected temporal interval compared to the first, in both cities, increase in the specified air temperature characteristics is mainly observed (except for the average absolute maximum of $T_{\min}$ and DTR in Baku, as well as the average absolute minimum in Tbilisi). In general, in both cities, the warming effect for the average values of the absolute minimum of the specified air temperature parameters is higher than for the average values of the absolute maximum of these parameters. At the same time, the greatest warming effect is observed in Baku for the average absolute minimum for $T_{\min}$ (increase of 2.9 °C) and in Tbilisi for the average absolute minimum for $T_{\max}$ (increase of 2.4 °C).

Key Words: Air temperature, thermal regime, regional climate, climate change, statistical analysis.

Introduction

Global warming, especially in recent decades, and the environmental problems associated with it are well known worldwide. Therefore, in many countries, special attention is paid to climate change research and the consequences of these changes on the environment, including human health [1,2]. Similar research is also actively led in Azerbaijan [3-6] and Georgia [7-10]. Based on the results of the research, it became evident that in both countries, against the backdrop of global climate change, a significant increase in air temperature has been observed in recent years.

For example, in our latest work [11] detailed statistical analysis of daily minimum ($T_{\min}$), maximum ($T_{\max}$), Daily Temperature Range, and average (T_{mean}) air temperatures in Baku and Tbilisi in 2005-2024 and their variability in 2020-2024 compared to 2005-2009 against the background of climate change has been analyzed. The significant impact of rapid climate warming over the past two decades on the growth of the specified air temperature characteristics in both cities is detected. Generally, as a result of rapid climate warming in the last two decades, both in Baku and Tbilisi, an increase in thermal risks to public health is observed. In our other work [12], submitted for publication, a detailed statistical analysis of the average monthly values of the above temperature parameters in Baku and Tbilisi for the same period of time was carried out. This work is a continuation of previous joint studies on climate change in Azerbaijan and Georgia [11, 12]. Results of statistical analysis of average values of daily absolute minimum, maximum, Daily Temperature Range and mean air temperature for each month of the year in Baku and Tbilisi in 2005-2024 and their variability in 2020-2024 compared to 2005-2009 are discussed below.

Study area, material, and methods

Study area – Baku (the capital of the Republic of Azerbaijan, 40.45 °N, 50.0667 °E, -4 m above sea level) and Tbilisi on other hand (the capital of the Republic of Georgia, 41.75785 °N, 44.7552 °E, 427 m above sea level). The distance between those cities is 470 km.

In order to conduct analysis, data from the National Environment Agency of Georgia and data [<http://www.pogodaiklimat.ru/>] on minimum ($T_{\min}$), maximum ($T_{\max}$), and mean (T_{mean}) daily air temperature in Baku and Tbilisi in 2005-2024 are used.

Object of study: daily absolute minimum ($T_{\min}$), maximum ($T_{\max}$), Daily Temperature Range (DTR) and mean (T_{mean}) air temperatures for each month of the year.

In the proposed work, the analysis of data is carried out with the use of the standard statistical analysis methods.

The following designations, except those specified above, will be used below: Range – maximal values – minimal values; daily temperature range – $\text{DTR} = T_{\max} - T_{\min}$. The difference of the average values of the studied parameters was carried out using the G2 criterion for comparing the frequencies of two occasional events with a significance level of no less than 0.5. B – Baku, T – Tbilisi. I – first period: 2005-2009, II – second period: 2020-2024, F – full period: 2005-2024.

Results

Results are presented in Tables 1-3 and Fig. 1.

Table 1. Statistical characteristics of absolute minimum and maximum values of the studied temperature parameters for each month of the year in 2005-2024.

Variable	$T_{\min_B}$	$T_{\min_T}$	$T_{\text{mean_B}}$	$T_{\text{mean_T}}$	$T_{\max_B}$	$T_{\max_T}$	DTR_B	DTR_T
Parameter	Absolute minimum							
Max	11.9	13.2	20.3	17.1	22.1	20.1	1.9	3.4
Min	-9.6	-13.9	-7.4	-9.7	-5.5	-4.8	0.2	0.6
Range	21.5	27.1	27.7	26.8	27.6	24.9	1.7	2.8
Average	1.1	0.0	6.4	4.1	8.1	6.2	1.0	1.6
St Dev	8.1	9.4	9.6	9.2	9.8	8.6	0.5	0.9
Parameter	Absolute maximum							
Max	31.1	27.0	33.5	32.1	42.7	40.6	25.8	21.9
Min	8.8	9.2	12.8	11.0	20.4	16.0	13.8	15.5
Range	22.3	17.8	20.7	21.1	22.3	24.6	12.0	6.4
Average	19.6	18.2	23.4	22.4	31.6	30.6	21.0	19.2
St Dev	7.5	6.8	7.7	7.5	8.1	8.3	3.6	2.1

Table 2. Statistical characteristics of absolute minimum and maximum values of the studied temperature parameters for each month of the year in 2005-2009.

Variable	$T_{\min_B}$	$T_{\min_T}$	$T_{\text{mean_B}}$	$T_{\text{mean_T}}$	$T_{\max_B}$	$T_{\max_T}$	DTR_B	DTR_T
Parameter	Absolute minimum							
Max	13.7	13.8	20.3	17.5	22.1	21.0	2.3	3.4
Min	-9.6	-12.4	-4.4	-7.8	-2.6	-3.4	0.2	1.0
Range	23.3	26.2	24.7	25.3	24.7	24.4	2.1	2.4
Average	2.3	1.4	8.0	5.6	9.8	7.8	1.1	2.0
St Dev	7.7	8.5	8.4	8.2	8.6	7.8	0.6	0.8
Parameter	Absolute maximum							
Max	31.1	25.2	31.3	30.4	38.2	40.0	25.8	19.6
Min	7.1	5.0	8.6	7.6	15.8	15.5	13.8	14.0
Range	24.0	20.2	22.7	22.8	22.4	24.5	12.0	5.6
Average	18.8	16.5	21.7	20.9	29.0	29.0	19.3	17.4
St Dev	7.6	7.1	7.7	8.1	7.3	8.4	4.1	1.6

Table 3. Statistical characteristics of absolute minimum and maximum values of the studied temperature parameters for each month of the year in 2020-2024.

Variable	T _{min} _B	T _{min} _T	T _{mean} _B	T _{mean} _T	T _{max} _B	T _{max} _T	DTR_B	DTR_T
Parameter	Absolute minimum							
Max	17.5	14.0	23.1	20.5	25.7	24.2	3.8	4.4
Min	-4.9	-8.0	-3.9	-2.9	0.9	0.0	0.9	0.6
Range	22.4	22.0	27.0	23.4	24.8	24.2	2.9	3.8
Average	5.2	2.9	9.5	7.5	11.7	10.2	2.1	2.0
St Dev	8.1	8.0	9.0	8.9	9.1	9.0	1.0	1.2
Parameter	Absolute maximum							
Max	27.6	26.3	32.8	32.1	41.9	40.6	20.8	21.9
Min	8.3	8.7	10.7	11.0	15.7	16.0	13.4	12.5
Range	19.3	17.6	22.1	21.1	26.2	24.6	7.4	9.4
Average	18.4	17.7	22.9	22.0	30.7	30.1	17.2	17.9
St Dev	7.2	6.8	7.9	7.7	8.5	8.4	2.3	2.6

In Tables 1-3 statistical characteristics of absolute minimum and maximum values of the studied temperature parameters for each month of the year in the three periods of time are presented.

In particular, from these Tables follows that:

For all time periods, the average values of the absolute minimum and maximum T_{min}, T_{mean} and T_{max} in Baku are higher than in Tbilisi (except for the average values of the absolute maximum T_{max} in the first time period, equal to 29.0 °C).

For the full and first time periods, the average values of the absolute minimum DTR in Baku are lower than in Tbilisi, and the average values of the absolute maximum DTR in Baku are higher than in Tbilisi.

For the second time period, on the contrary, the average values of the absolute minimum DTR in Baku are higher than in Tbilisi, and the average values of the absolute maximum DTR in Baku are lower than in Tbilisi.

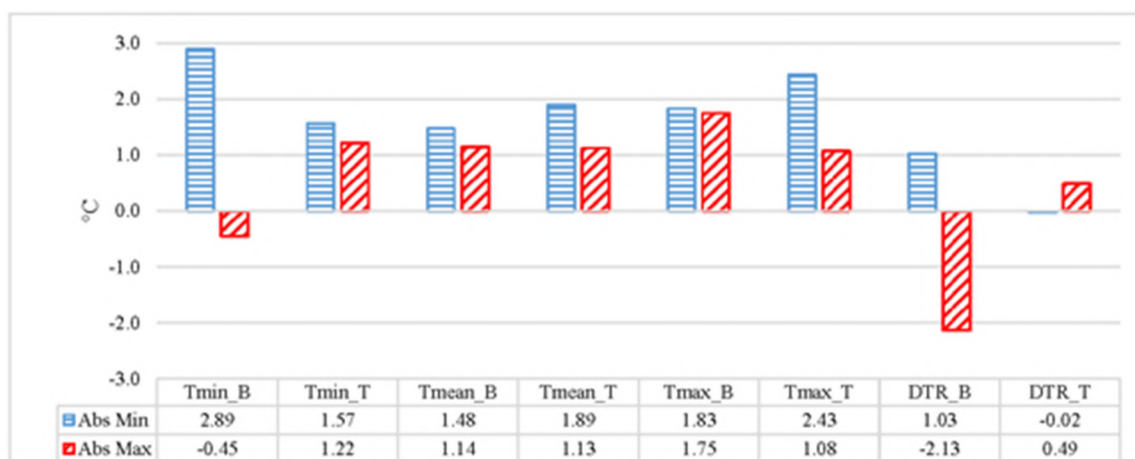


Fig. 1. Difference between mean values of the absolute minimum and maximum values of the studied temperature parameters for each month of the year in 2020-2024 and 2005-2009.

In Fig. 1 calculated difference data between the mean values of the absolute minimum and maximum values of the studied temperature parameters for each month of the year in 2020-2024 and 2005-2009 are presented.

As it follows from Fig. 1 in the second period of time, compared to the first, in both cities, an increase in the specified air temperature characteristics is mainly observed (except for the average absolute maximum of T_{min} and DTR in Baku, as well as the average absolute minimum in Tbilisi). In general, in both cities, the warming effect for the average values of the absolute minimum of the specified air temperature parameters is

higher than for the average values of the absolute maximum of these parameters. The greatest warming effect is observed in Baku for the average absolute minimum for $T_{\min}$ (an increase of 2.9 °C) and in Tbilisi for the average absolute minimum for $T_{\max}$ (an increase of 2.4 °C).

Conclusion

In the near future, it is planned to continue joint research both in terms of climate change and in terms of assessing environmental risks, including public health, associated with air temperature and various thermal indices in individual seasons and months of the year.

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