

CHANGEABILITY OF AIR TEMPERATURE AND ATMOSPHERIC PRECIPITATIONS IN TBILISI FOR 175 YEARS

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Summary: A statistical analysis of data on monthly and seasonal values of air temperature and precipitation in Tbilisi from 1844 to 2018 was carried out. Trends of air temperature and precipitation in three period of year (year, cold and warm seasons) for 175 year observations is study. Comparison of monthly and seasonal mean values of air temperature and precipitations in two thirty years of time (1844-1873 and 1989-2018) was carried out. In particular, it was found that in the indicated periods of time there is a significance increase in air temperature for all months of the year, except May and November. As for precipitation, their growth is observed in October and November, and a decrease in July and September.

Key Words: Climate change, air temperature, atmospheric precipitations.

Introduction

In recent years the problem of observed and expected climate change on our planet acquired special urgency [1]. This problem has high importance in Georgia, because of the variety of climatic regions in its territory [2, 3]. In our last studies with the use of different statistical models the statistical structure and estimations of the expected changes of air temperature [3-10] and atmospheric precipitations [5, 11-16] for the next decades for some regions of Georgia, including Tbilisi city, were carried out.

In Tbilisi regular meteorological observations were begun into 1844. In this work standard statistical analysis of changeability of air temperature and atmospheric precipitations in Tbilisi in 1844-2018 is carried out.

Material and methods

Data of the Hydrometeorological department of Georgia about monthly mean air temperature and monthly sum of precipitation in Tbilisi in the period from 1844 to 2018 are used. The standard statistical methods are used. The following designations will be used below: Mean – average values; Min – minimal values; Max – maximal values; St Dev – standard deviation; R^2 – coefficient of determination; T – air temperature, °C; P – sum of precipitation, mm. Missing observational data using standard methods were recovered. Comparison of mean values of air temperature and precipitations in two thirty years of time (1844-1873 and 1989-2018) was produced with the use of Student's criterion with the level of significance α not worse than 0.15.

Results and discussion

Results in Table 1, 2 and Fig. 1-4 are presented.

In Table 1 statistical characteristics of monthly mean and seasonal values of air temperature in Tbilisi are presented. As follows from this Table monthly mean values of air temperature changes from 1.3 °C (January) to 24.6 °C (July). Range of changeability of (Max – Min) monthly mean values of air temperature composes 32.9 °C (-4.1°C in January and 28.8 °C in August).

Trends of seasonal values of air temperature in Tbilisi are positive (level of significance $\alpha(R^2) < 0.001$) and take the linear forms (Fig. 1). In the cold half-year an increase of air temperature is more intensive than into the warm period. Rate of growth of air temperature in different seasons of year are following: Year – 0.62 °C/Century, Cold Period – 0.75 °C/Century, Warm Period – 0.48 °C/Century.

Table 1

Statistical Characteristics of Air Temperature in Tbilisi in 1844-2018 (°C)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Cold	Warm	Year
Min	-4.1	-2.1	1.8	7.4	15.0	18.7	21.9	21.3	15.4	9.5	0.4	-3.6	3.1	17.6	11.3
Max	6.3	7.3	11.9	17.0	22.3	24.9	28.1	28.8	23.5	17.7	10.9	9.2	9.1	21.9	15.3
Mean	1.3	2.7	6.8	12.2	17.5	21.4	24.6	24.4	19.7	13.9	7.7	3.2	5.9	20.0	13.0
StDev	2.1	2.1	1.8	1.7	1.3	1.3	1.2	1.4	1.5	1.5	1.6	1.8	1.0	0.8	0.7
Level of Significance of Difference: T(1989-2018) – T(1844-1873)															
α	<0.01	<0.01	0.02	0.01	No	<0.01	0.12	<0.01	0.01	0.15	No	0.02	<0.01	<0.01	<0.01

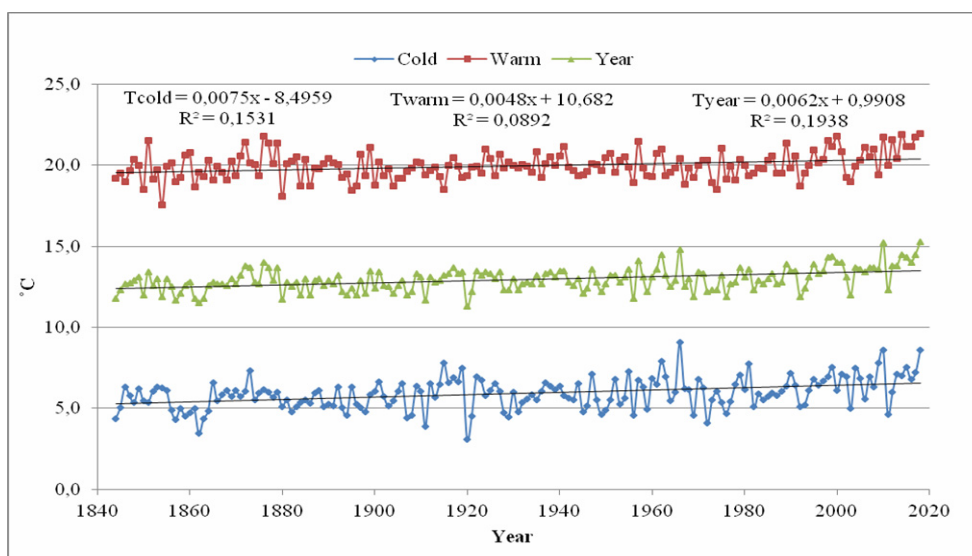


Fig. 1. Trend of Air Temperature in Tbilisi in Three Period of Year in 1844-2018.

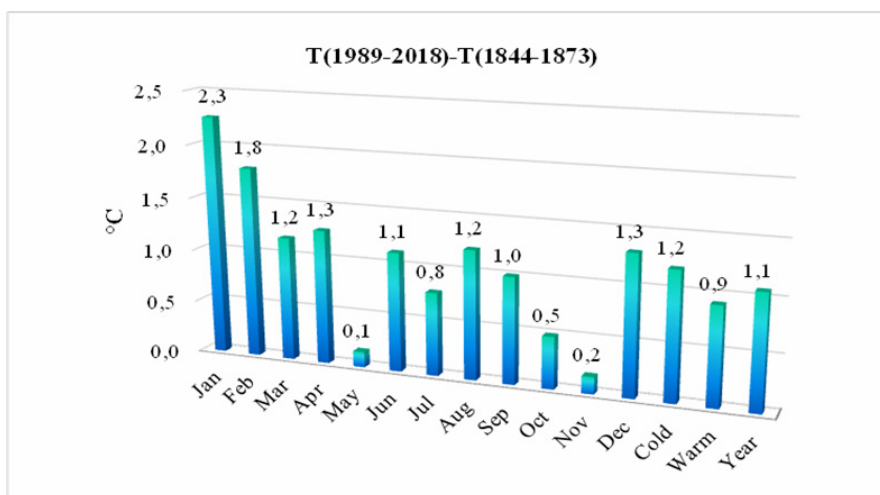


Fig. 2. Difference between Air Temperature in Tbilisi in 1989-2018 and 1844-1873.

In Fig. 2 data about difference between air temperature in Tbilisi in 1989-2018 and 1844-1873 are presented. As follows from Fig. 2 and Table 1 in the indicated periods of time there is a significance increase in air temperature for all months and seasons of the year, except May and November. The greatest increase of the air temperature in second thirty-year period of time in comparison with the first period is observed during January (2.3 °C), smallest – in October (0.5 °C). In the cold half-year an increase of the air temperature composes 1.2 °C, into warm – 0.9 °C, as a whole in the year – 1.1 °C.

In Table 2 statistical characteristics of monthly and seasonal sum of precipitations in Tbilisi are presented. As follows from this Table mean monthly sum of precipitations changes from 16 mm (January) to 82 mm (July). Range of changeability (Max – Min) of monthly sum of precipitations compose 267 mm (0 mm in all months, besides April and June, 267 mm – in May).

Trend of seasonal values of sum precipitations in Tbilisi only in cold period of year is observed (positive linear trend, level of significance $\alpha(R^2) = 0.03$, Fig. 3). Rate of growth of sum precipitations in this period compose 17 mm/Century.

Table 2

Statistical Characteristics of Atmospheric Precipitations in Tbilisi in 1844-2018 (mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Cold	Warm	Year
Min	0	0	0	5	0	3	0	0	0	0	0	0	71	131	240
Max	68	87	92	187	267	265	175	203	200	139	126	84	308	690	814
Mean	16	21	30	52	82	73	48	40	43	41	32	21	162	338	499
StDev	13	16	20	31	46	43	35	33	33	30	24	17	49	94	104
Level of Significance of Difference: P(1989-2018) – P(1844-1873)															
α	No	No	No	No	No	No	0.11	No	0.13	0.09	0.08	No	0.03	No	No

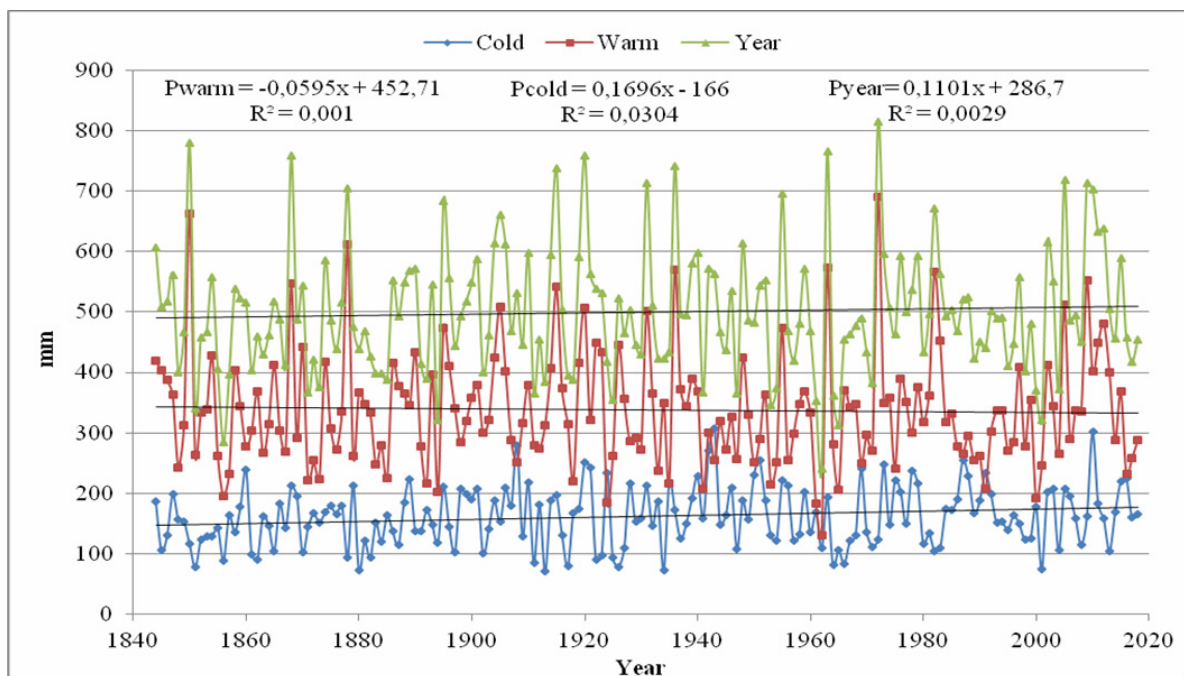


Fig. 3. Trend of Atmospheric Precipitation in Tbilisi in Three Period of Year in 1844-2018.

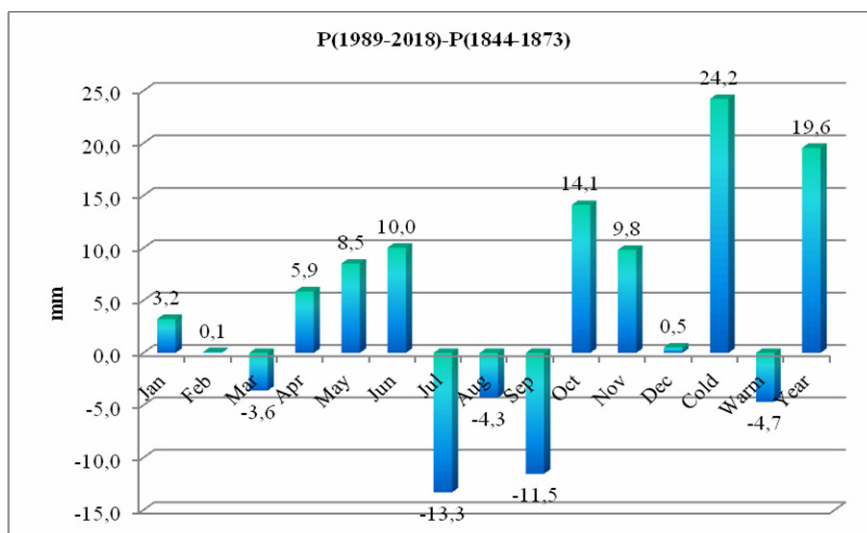


Fig. 4. Difference between Atmospheric Precipitations in Tbilisi in 1989-2018 and 1844-1873.

In Fig. 4 data about difference between sum of precipitations in Tbilisi in 1989-2018 and 1844-1873 are presented. As follows from Fig. 4 and Table 2 in the indicated periods of time there is a significance increase of sum of precipitations in October (14 mm) and November (10 mm), and decrease – in July (13 mm) and September (11.5 mm). In the cold half-year an increase sum of precipitations composes 24 mm.

Conclusion

In the near future, it is planned to analyze these data using statistical methods for non-stationary series of observations.

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