

CHANGEABILITY OF THE TOTAL CLOUDINESS IN TBILISI IN 1956-2015

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Summary: *The results of a statistical analysis of the monthly, semiannual and annual values of total cloudiness G in Tbilisi in 1956-2015 are represented. In particular, it was found that in the period from 1986 to 2015 compared to the period 1956-1985 in Tbilisi for all months and periods of the year (with the exception of August and December - no change of G values, and October - increase of cloudiness), there is a decrease of the values of total cloudiness. The linear trends of total cloudiness were studied for the period from 1956 to 2015. It is shown that the largest decrease of G values in 2015 compared to 1956 relative to the average value of total cloud cover in 1956-2015 was observed in June: -20.3%, the smallest - in April: -6.4%.*

Key Words: *Total cloudiness, climate change.*

Introduction

In Georgia, as in the rest of the world, in recent decades, special attention has been paid to the study of modern climate change [1,2]. Cloudiness is one of the important climate forming factors [1-3]. In particular, a number of studies have been carried out in Georgia to study long-term variations in total and lower cloudiness [4], the influence of cloudiness on the solar radiation regime [5,6], the effect of cosmic radiation on cloudiness [7,8], bioclimatic characteristics of cloudiness [9-11], etc.

In this work, which presents the continuation of the foregoing studies, some results of the changeability of the monthly, semiannual and annual values of total cloudiness in Tbilisi in 1956-2015 are represented.

Material and methods

Data of the National Environmental Agency of Georgia about mean monthly values of total cloudiness (G) in Tbilisi in 1956-2015 are used. The standard statistical methods are used. The following designations will be used below: Mean – average value of G for 1956-2015; Min – minimal values; Max - maximal values; St Dev -standard deviation; σ_m - standard error, (68% - confidence interval of mean values); Cv - coefficient of variation, (%), R^2 - coefficient of determination, R – coefficient of correlation; $\alpha(R)$ - the level of significance α of R; a and b – linear trend regression equation coefficients; 95%(+/-) - 95% of the lower and upper levels of the confidence interval of the average values; Year – mean annual values of G; Cold - mean values of G from October to March; Warm – mean values of G from April to September; (I) – average value of G for 1956-1985 (first period of time); (II) - average value of G for 1986-2015 (second period of time). Missing observational data using standard methods were recovered. Comparison of mean values of precipitations in two periods of time was produced with the use of Student's criterion with the level of significance not worse than 0.2. The unit of measurement of cloud cover is one tenth of the sky, it is omitted below.

Results and discussion

Results in tables 1-2 and fig. 1-2 are presented.

Table 1. Statistical characteristics of monthly, annual and semiannual values of total cloudiness in Tbilisi in 1956-2015.

Parameter	Mean	Min	Max	St Dev	σ_m	Cv (%)	95%(+/-)
Jan	6.4	4.0	9.0	1.12	0.15	17.5	0.29
Feb	6.6	3.8	8.3	1.06	0.14	15.9	0.27
Mar	6.9	4.1	9.0	1.00	0.13	14.7	0.26
Apr	6.8	5.0	8.2	0.80	0.10	11.7	0.20
May	6.5	4.8	8.7	0.79	0.10	12.3	0.20
Jun	5.6	4.0	8.0	0.83	0.11	14.9	0.21
Jul	5.3	3.0	7.1	0.79	0.10	15.0	0.20
Aug	5.1	2.0	7.2	1.00	0.13	19.8	0.26
Sep	5.3	3.0	7.0	0.94	0.12	17.6	0.24
Oct	5.8	3.0	9.0	1.10	0.14	19.0	0.28
Nov	6.3	3.1	9.0	1.17	0.15	18.6	0.30
Dec	6.2	3.5	8.2	1.05	0.14	17.0	0.27
Year	6.1	5.2	6.9	0.39	0.05	6.5	0.10
Cold	6.4	4.9	7.4	0.56	0.07	8.8	0.14
Warm	5.8	4.7	6.8	0.44	0.06	7.6	0.11

In table 1 the statistical characteristics of monthly, annual and semiannual values of total cloudiness in Tbilisi in 1956-2015 is presented. In particular, as follows from this table the monthly values of G changes from 2.0 (August) to 9.0 (January, March, October and November). The greatest variations in the values of G are observed during August ($C_v = 19.8\%$), smallest - in April ($C_v = 11.7\%$). The mean values of G changes from 5.1 (August) to 6.9 (March).

Table 2. Characteristics of changeability of total cloudiness in Tbilisi in 1956-2015.

Parameter	(II) – (I)	R	$\alpha(R)$	a	b	{G(2015)-G(1956)}/Mean, %
Jan	-0.4	-0.15	0.25	-0.0095	25.246	-8.9
Feb	-0.5	-0.15	0.25	-0.0090	24.422	-8.1
Mar	-0.7	-0.35	0.01	-0.0199	46.386	-17.4
Apr	-0.4	-0.16	0.22	-0.0073	21.274	-6.4
May	-0.7	-0.41	<0.005	-0.0186	43.464	-17.3
Jun	-0.6	-0.40	<0.005	-0.0189	43.197	-20.3
Jul	-0.4	-0.23	0.08	-0.0105	26.113	-11.9
Aug	No	-0.12	0.36	-0.0067	18.482	-7.9
Sep	-0.4	-0.13	0.32	-0.0069	19.085	-7.8
Oct	0.4	0.20	0.13	0.0124	-18.894	12.8
Nov	-0.4	-0.19	0.15	-0.0126	31.348	-12.0
Dec	No	-0.22	0.09	-0.0134	32.704	-13.1
Year	-0.4	-0.45	<0.005	-0.0101	26.069	-10.0
Cold	-0.3	-0.27	0.04	-0.0087	23.535	-8.2
Warm	-0.4	-0.46	<0.005	-0.0115	28.602	-12.0

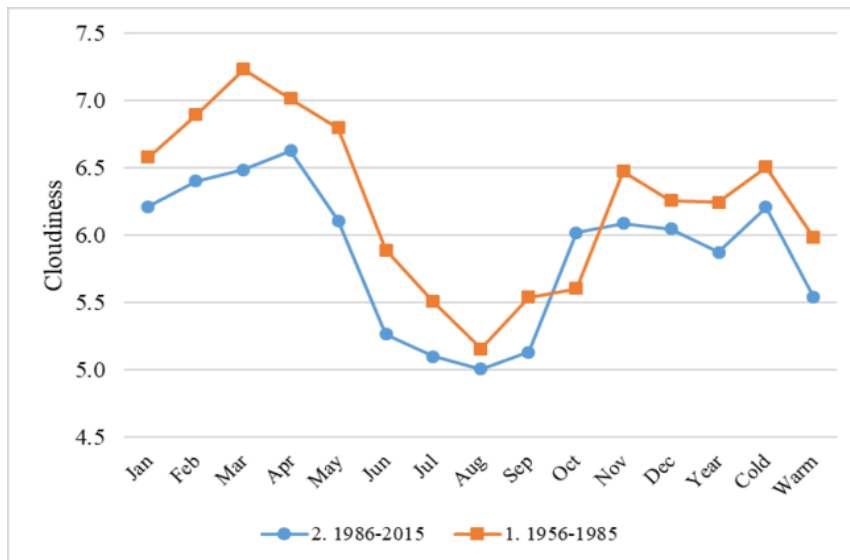


Fig. 1. The intraannual diatributions of mean monthly and seasonal values of total cloudiness in Tbilisi in 1956-1985 and 1986-2015.

In table 2 and fig. 1 the characteristics of changeability of monthly, annual and semiannual values of total cloudiness in Tbilisi in 1956-2015 is presented. Table 2 also presents data on the values of the coefficients of the linear regression equation a and b of the cloudiness trend in 1956-2015. In particular, as it follows from table 2 and fig. 1 in the period from 1986 to 2015 compared to the period 1956-1985 in Tbilisi for all months and periods of the year (with the exception of August and December - no change of G values, and October - increase of cloudiness), there is a decrease of the values of total cloudiness. The largest decrease of G values in 2015 compared to 1956 relative to the average value of total cloud cover in 1956-2015 was observed in June: -20.3%, the smallest - in April: -6.4%.

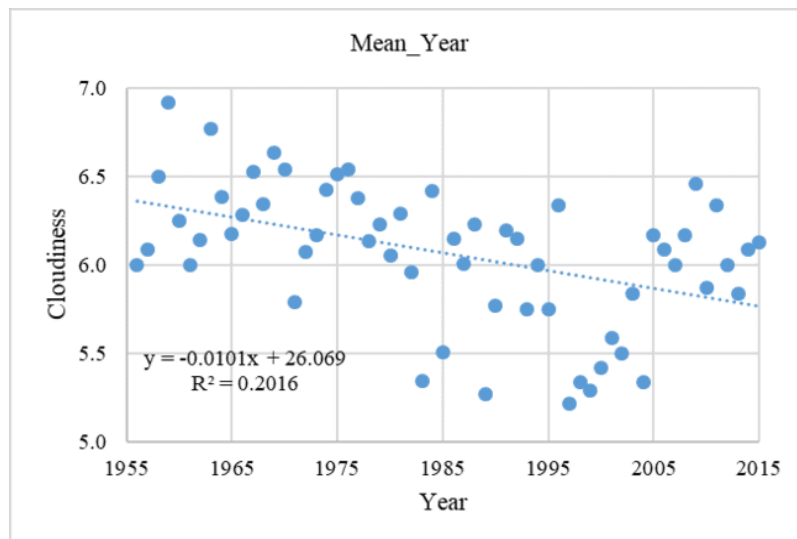


Fig. 2. Trend of the mean annual values of total cloudiness in Tbilisi in 1956-2015.

In fig. 2 example of linear trend of the mean annual values of total cloudiness in Tbilisi in 1956-2015 is presented.

Conclusion

In the future, similar studies will be carried out for other locations in Georgia.

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