

CHANGEABILITY OF MONTHLY MEAN VALUES OF SURFACE OZONE CONCENTRATION (SOC) IN THREE POINTS OF TBILISI FROM JANUARY 2017 TO OCTOBER 2021

Kharchilava J., Kekenadze E.

*Mikheil Nodia Institute of Geophysics of Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia
kekenadze@gmail.com*

Summary: *The statistical characteristics of the surface ozone concentration (SOC) in three points of Tbilisi city (A. Kazbegi av., A. Tsereteli av. and Varketili) from January 2017 to October 2021 are represented. The data of National Environmental Agency of Georgia about the mean monthly values of SOC are used. In particular, it is obtained that the greatest average values of SOC during entire period of observations in Varketili were observed (68.0 mcg/m³), smallest - on A. Tsereteli av. (43.9 mcg/m³). The value of the linear correlation coefficient between the mean monthly values of SOC on all points changes from 0.88 to 0.96. The influence of limitation on the movement of public transport in Georgia in different time periods from March 2020 to August 2021 in connection with the pandemic of coronavirus COVID-19 to the changeability of the level of SOC is studied.*

Key Words: *surface ozone concentration, ecology.*

Introduction

Atmospheric ozone is one of the most important species defining the quality of life [1-3]. Therefore, special attention in many countries of world, including in Georgia, is paid to studies of surface ozone concentration (SOC) [4-10].

The ozone concentration in the atmospheric surface layer, varies widely depending on photochemical processes, horizontal advection, intrusions of stratospheric air, vertical mixing, dry and humid deposition, etc. In particular limitation on the movement of public transport in Georgia in connection with the pandemic of coronavirus COVID-19 influenced the ozone content in the air in Tbilisi, causing it to some rise [11,12].

In recent years, the Environment Agency has been monitoring surface ozone concentrations in Georgia in accordance with international standards. This paper presents the results of a statistical analysis of monthly mean data of SOC values at three points in of Tbilisi from January 2017 to October 2021, including period with limitation on the movement of public transport in Georgia in different time periods from March 2020 to August 2021 in connection with the pandemic of coronavirus COVID-19.

Study area, material and methods

Study area – three locations of Tbilisi (A. Kazbegi av. – KZBG, A. Tsereteli av. – TSRT, Varketili – VRKT). Coordinates of this locations of air pollution measurements points in [10] are presented.

The data of Georgian National Environmental Agency about the surface ozone concentration (SOC) in three points of Tbilisi city are used [http://air.gov.ge/reports_page]. Period of observation: January 1, 2017- October 31, 2021.

The data analysis with the use of standard statistical methods was conducted. The following designations will be used below: Mean – average values; Min – minimal values; Max - maximal values; Range = Max-Min; St Dev – standard deviation; Cv = 100·St Dev/Mean, coefficient of variation (%); 99% Low and 99% Upp – 99% confidence interval of lower and upper calculated level accordingly; R – coefficient of linear correlation. Comparison of mean values of SOC in two periods of time was produced with the use of Student's criterion with the level of significance α not worse than 0.25.

Results and discussion

Results in fig. 1-3 and tables 1-2 are presented.

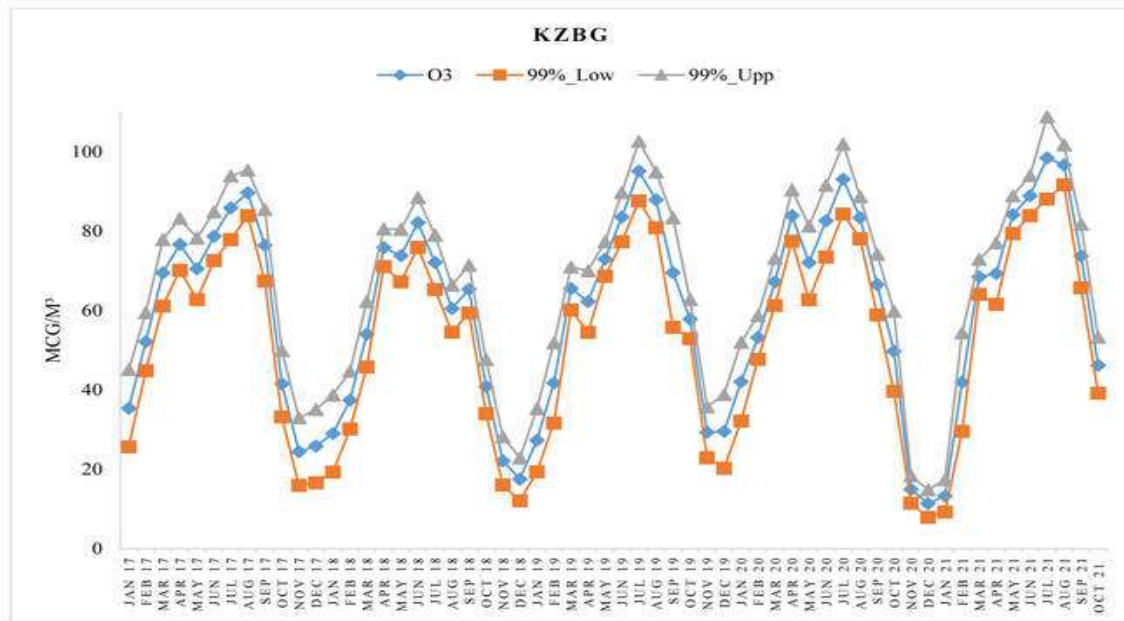


Fig. 1. Monthly mean values of SO₂ and their 99% confidence intervals on the A. Kazbegi av. from January 2017 to October 2021.

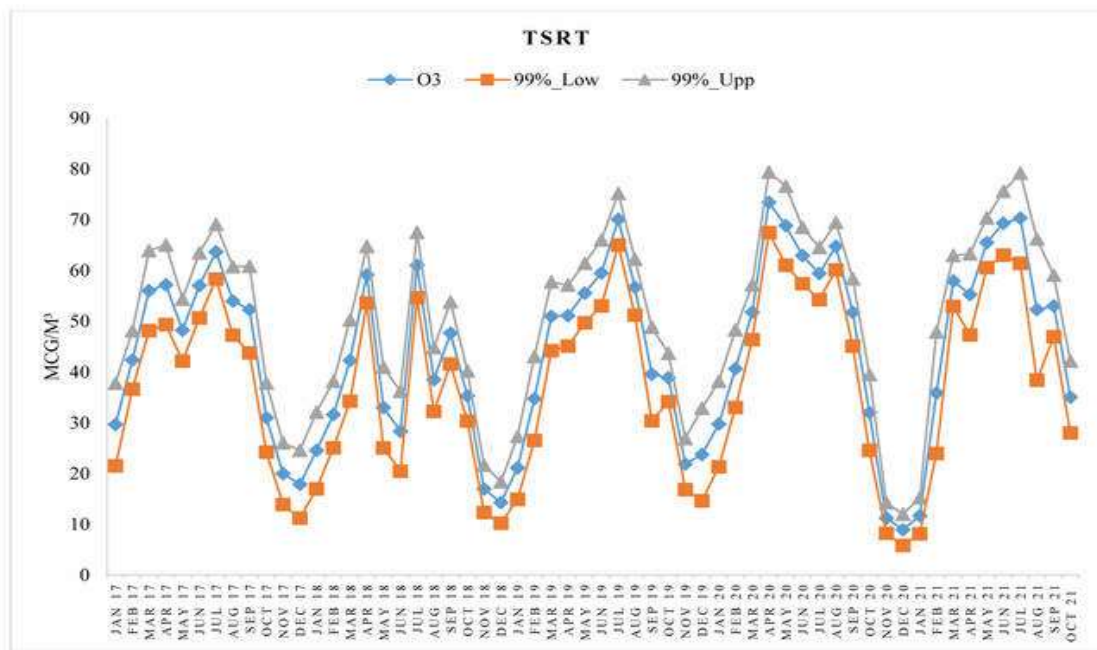


Fig. 2. Monthly mean values of SO₂ and their 99% confidence intervals on the A. Tsereteli av. from January 2017 to October 2021.

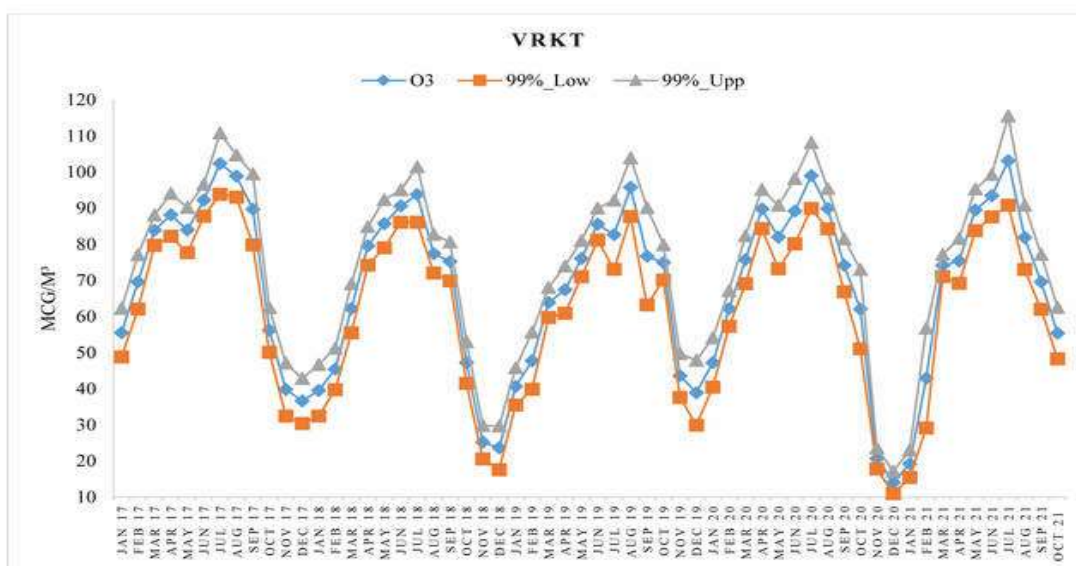


Fig. 3. Monthly mean values of SOC and their 99% confidence intervals in Varketili from January 2017 to October 2021.

In fig. 1-3 data about monthly mean values of SOC and their 99% confidence intervals on the three points of measurements in Tbilisi city in the investigation period are presented.

As follows from these figures, the intra-annual distribution of SOC in Tbilisi as is wave-like - an increase in the warm half-year, a decrease in the cold season of the year.

Table 3. Statistical characteristics of the monthly mean values of SOC at three points of Tbilisi from January 2017 to October 2021 (mcg/m³).

| Parameter | KZBG | TSRT | VRKT |
|-------------------------------|------|------|-------|
| Max | 98.4 | 73.4 | 103.1 |
| Min | 11.3 | 8.9 | 14.0 |
| Range | 87.1 | 64.5 | 89.1 |
| Mean | 60.0 | 43.9 | 68.0 |
| St Dev | 24.3 | 17.5 | 23.6 |
| Cv, % | 40.5 | 39.9 | 34.7 |
| Correlation Matrix (R) | | | |
| KZBG | 1 | 0.91 | 0.96 |
| TSRT | 0.91 | 1 | 0.88 |
| VRKT | 0.96 | 0.88 | 1 |

The statistical characteristics of the monthly mean values of SOC for three points of Tbilisi from January 2017 to October 2021 in table 1 are presented. As it follows from this table and fig. 1-3 the monthly mean value of SOC changes from 8.9 mcg/m³ (TSRT) to 103.1 mcg/m³ (VRKT).

The greatest average values of SOC during entire period of observations in the Varketili were observed (68.0 mcg/m³), smallest - on A. Tsereteli av. (43.9 mcg/m³).

The values of the linear correlation coefficient between the mean monthly values of SOC on all points changes from 0.88 to 0.96 (table 1).

In connection with the pandemic of coronavirus COVID-19 in Georgia were introduced the limitations in the movement of different type of transport in different time periods from March 2020 to August 2021.

The preliminary studies of the influence of these limitations on the daily and monthly content of SOC in Tbilisi in spring 2020 are given to [11,12].

Data about influence of the various limitation on the movement of transport in Georgia from March 2020 to August 2021 in connection with the pandemic of coronavirus COVID-19 to the mean level of SOC in this period of time are presented below.

Table 2 presents the data about changeability of mean values of SOC at three points of Tbilisi city in three periods of time. I. March 2017-August 2018, first pre-pandemic period; II. March 2018 - August 2019, second pre-pandemic period; III. March 2020 - August 2021, period with pandemic.

Table 2. Changeability of mean values of SOC at three points of Tbilisi city in three periods of time, mcg/m³

| Parameter | KZBG | TSRT | VRKT |
|--|---------|-------------------------------|---------|
| I. Mean (Mar 2017-Aug 2018) | 62.4 | 43.1 | 74.7 |
| II. Mean (Mar 2018 - Aug 2019) | 61.1 | 43.1 | 67.8 |
| III. Mean (Mar 2020 - Aug 2021) | 65.9 | 50.1 | 70.9 |
| Differ. (II-I) | No sign | | |
| Differ. (III-II) | No sign | 7.0 ($\alpha \approx 0.25$) | No sign |
| Differ. (III-I) | No sign | 7.1 ($\alpha \approx 0.25$) | No sign |

In particular, as it follows from table 2, in the second period of time, as compared with the first, the average ozone content did not change at any of the measurement points. In the third time period (the period of the pandemic), as compared to the first and the second, an increase in the mean ozone content at Tsereteli measurement point (+7 mcg/m³) is noted. For the other two measurement points, stability is observed in the variability of SOC.

Conclusion

Over the long term is planned the more detailed study of variations of surface ozone concentration in Tbilisi and other cities of Georgia, identifying the links between SOC and other air pollutants, etc.

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