Journal of the Georgian Geophysical Society, ISSN: 1512-1127
Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 22(2), 2019, pp. 63 - 67

Statistical Characteristics of Surface Ozone Concentration in Three Points of Tbilisi in 2017-2018

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ABSTRACT

The statistical characteristics of surface ozone concentration (SOC) in three points of Tbilisi city (A. Kazbegi av., A. Tsereteli av. and Varketili) in 2017-2018 are represented. The data of *National Environmental Agency of Georgia about the eight hour values of SOC are used.*

In particular, it is obtained that the greatest average annual values of SOC in Varketili were observed (53.9 μg/m³, the range of the change: 1-134 μg/m³), smallest – at the A. Tsereteli av. (21.6 μg/m³, the range of the change: 0-102 μg/m³). The value of the correlation coefficient between the eight hour values SOC between the points sufficiently high and changes from 0.74 to 0.91.

The correspondence of values of SOC at the indicated points of Tbilisi city to the standards of WHO is examined.

Key Words: surface ozone concentration, ecology

Introduction

It is known, that atmospheric ozone is one of the most important species defining the quality of life [1,2]. Therefore, special attention in many countries of world, including in Georgia, is paid to studies of surface ozone concentration (SOC) [3-13].

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 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 eight-hour data of SOC values at three points in of Tbilisi in 2017 and 2018.

Study area, material and methods

Study area – three locations of Tbilisi. In Table 1 coordinates and locations of air pollution measurements points in Tbilisi are presented.

Table 1

Coordinates of air pollution measurements points in Tbilisi

No	Location	Location, Abbreviation	Latitude, N°	Longitude, E°	H, m
1	**Varketili**	**VRKT**	41.699947	44.871611	518
2	**A. Kazbegi av.**	**KZBG**	41.724767	44.752956	467
3	**A. Tsereteli av.**	**TSRT**	41.742539	44.779069	423

The eight hourly 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- December 31, 2018

The data analysis with the use of standard statistical methods was conducted [14]. The following designations will be used below: Mean – average values; Min – minimal values; Max - maximal values; Range = Max-Min; St Dev – standard deviation; σ_m - standard error ; Cv = 100·St Dev/Mean, coefficient of variation (%); Count - the number of measurements; R – coefficient of linear correlation; 99% Low and 99% Upp – 99% confidence interval of lower and upper calculated level accordingly. The difference between the mean values of SOC with the use of Student's criterion was determined (level of significance α is not worse than 0.001).

In the correspondence with the standards of the World Health Organization maximum permissible concentration (MPC) composes eight hourly mean for SOC - 100 μg/m³ [15].

Table 2 verbal description of the level of aerosol pollution of the atmosphere (so-called O_3 Index) depicts [Air quality index - http://air.gov.ge/en/pages/11/11].

Table 2

O_3 Index

Pollutants	Good	Fair	Moderate	Poor	Very Poor
O_3 - Ozone, μg/m³	0-80	80-120	120-180	180-240	240-600

Results and discussion

Results in Table 3 and Fig. 1 are presented.

The statistical characteristics of eight-hour values of SOC for three point of Tbilisi in Table 3 are presented. As it follows from this Table, mean annual values of SOC in each year of observations at all three stations differ from each other ($\alpha \leq 0.001$). In 2018 in comparison with 2017 mean annual values of SOC on all points of measurement decreased.

The smallest mean annual values of SOC are observed on A. Tsereteli av. (27.9 and 21.6 μg/m³ respectively into 2017 and 2018), and greatest - in Varketili (53.9 and 46.3 μg/m³ respectively into 2017 and 2018).

Range of a change in the eight-hour values of SOC in two years of observation - from 0 to 133.5 μg/m³. Changeability in the time of values of SOC is sufficiently high (Cv changes from 49.9 to 70.7 % in 2017 and from 59.0 to 80.4 % in 2018).

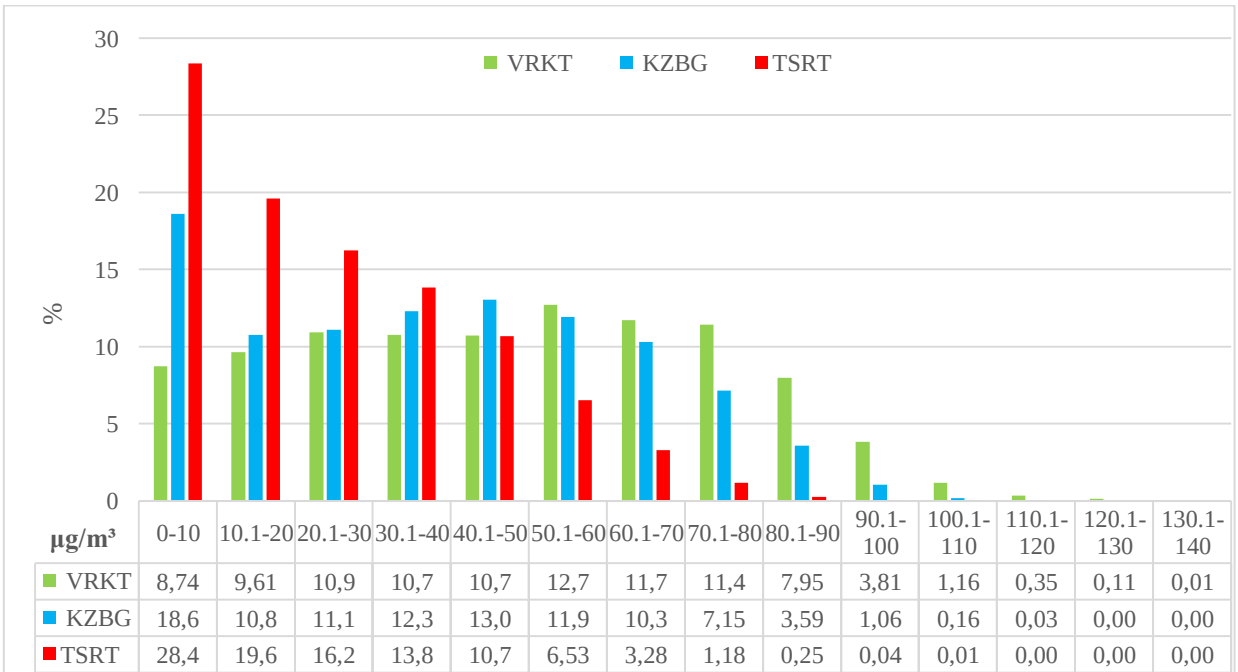
The values of the coefficient of linear correlation between the observation points into 2017 and 2018 cover the range 0.74÷0.91 (or, in the correspondence with the Chaddock scale correlation – "strong").

Fig. 2 presents the data about the repetition of eight-hour values of SOC in two years of measurements for three points of Tbilisi into the correspondence with the scale of O_3 index (Table 2). As follows from this Fig. the repetition of values of SOC in the range "Poor ÷ Very Poor" for all points it is equal to zero. Repetition of values of SOC ≥ 100 μg/m³ is the following: in Varketili - 1.63 %, on A. Kazbegi av. - 0.19 %, on A. Tsereteli av. – 0.01 %. I.e., for all three points of measurement both into 2017 and in 2018 the values of SOC above maximum permissible concentration in the correspondence with the standards of WHO [15] practically are absent.

Table 3

Statistical characteristics of the 8-hour mean values of SOC at three points of Tbilisi in 2017 and 2018 (μg/m³)

Parameter	SOC					
Year	2017			2018		
Location	VRKT	KZBG	TSRT	VRKT	KZBG	TSRT
Mean	53.9	41.6	27.9	43.6	35.0	21.6
Min	2.1	0.6	0.0	1.1	0.0	0.0
Max	133.5	116.0	94.8	125.0	113.8	101.9
Range	131.4	115.4	94.8	123.9	113.8	101.9
St Dev	26.7	26.1	19.7	25.7	23.6	17.3
σm	0.30	0.29	0.22	0.28	0.25	0.19
Cv (%)	49.6	62.6	70.7	59.0	67.6	80.4
Count	7918	7844	7777	8579	8608	8522
99% Low	53.1	40.9	27.3	42.9	34.3	21.1
99% Upp	54.7	42.4	28.5	44.3	35.6	22.0
	Correlation Matrix			Correlation Matrix		
VRKT	1	0.88	0.84	1	0.91	0.74
KZBG	0.88	1	0.85	0.91	1	0.76
TSRT	0.84	0.85	1	0.74	0.76	1
≥100 μg/m³						
%	2.34	0.31	0.00	1.00	0.10	0.02



μg/m³	0-10	10.1-20	20.1-30	30.1-40	40.1-50	50.1-60	60.1-70	70.1-80	80.1-90	90.1-100	100.1-110	110.1-120	120.1-130	130.1-140
VRKT	8,74	9,61	10,9	10,7	10,7	12,7	11,7	11,4	7,95	3,81	1,16	0,35	0,11	0,01
KZBG	18,6	10,8	11,1	12,3	13,0	11,9	10,3	7,15	3,59	1,06	0,16	0,03	0,00	0,00
TSRT	28,4	19,6	16,2	13,8	10,7	6,53	3,28	1,18	0,25	0,04	0,01	0,00	0,00	0,00

Fig. 1. Repetition of SOC in three point of Tbilisi in 2017-2018

However, this by no means does not testify about the purity of air in Tbilisi. The low concentrations of ozone are caused by the high level of the aerosol pollution of the atmosphere [16], by the expenditure of ozone for photochemical transformation of gas components of the atmosphere [2], etc. Therefore, ozone, together with other aerosol and gas components, creates an extremely unfavorable ecological situation in Tbilisi, contributing to an increase in mortality due to air pollution [2], in terms of which Georgia (after Serbia) is in second place in Europe [https://www.cei.int/ansa/76693].

Conclusion

Over the long term is planned the more detailed study of variations of surface ozone concentration in Tbilisi and other cities of Georgia.

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2017-2018 წლებში მიწისპირა ოზონის კონცენტრაციის სტატისტიკური მახასიათებლები თბილისის სამ პუნქში

ე. კეკენაძე

რეზიუმე

წარმოდგენილია მიწისპირა ოზონის კონცენტრაციის (მოკ) სტატისტიკური მახასიათებლები ქალაქ თბილისის სამ პუნქტში (ა.ყაზბეგის პრ., ა.წერეთელის პრ. და ვარკეთილი) 2017-2018 წლებში. გამოყენებულია გარემოს ეროვნული სააგენტოს მონაცემები მოკ-ის რვა საათიანი საშუალო მნიშვნელობების შესახებ. კერძოდ მიღებულია რომ მოკ-ის მაქსიმალური საშუალოწლიური მნიშვნელობები დაიკვირვებოდა ვარკეთილში (53.9 მკგ/მ^3, ცვლილების დიაპაზონი: 1-134 მკგ/მ^3), მინიმალური - ა. წერეთელის პროსპექტზე (21.6 მკგ/მ^3, ცვლილების დიაპაზონი: 0-102 მკგ/მ^3). წრფივი კორელაციის კოეფიციენტის მნიშვნელობები მოკ-ის სიდიდეებს შორის სხვადახვა პუნქტებზე საკმაოდ მაღალია და იცვლება 0.74 -დან 0.91-მდე. განხილულია მოკ-ის მნიშვნელობების შესაბამისობა მჯო-ს ნორმებთან.

Статистические характеристики концентрации приземного озона в трех пунктах Тбилиси в 2017-2018 гг.

Э.Н. Кекенадзе

Резюме

Представлены статистические характеристики концентрации приземного озона (КПО) в трех пунктах города Тбилиси (пр. А. Казбеги, пр. А. Церетели и Варкетили) в 2017-2018 гг. Использованы данные национального агентства по окружающей среде о восьмичасовых значениях КПО. В частности, получено, что наибольшие среднегодовые значения КПО наблюдались в Варкетили (53.9 мкг/м^3, диапазон изменения: 1-134 мкг/м^3), наименьшие – на пр. А. Церетели (21.6 мкг/м^3, диапазон изменения: 0-102 мкг/м^3). Величина коэффициента корреляции между значениями КПО между пунктами достаточно высокая и меняется от 0.74 до 0.91.
Рассмотрено соответствие значений КПО в указанных пунктах города Тбилиси нормам ВОЗ.