Connection between surface ozone concentration and visibility in Tbilisi

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1. INTRODUCTION

The surface ozone concentration is the straight characteristic of the atmospheric pollution [Amiranashvili et al., 2004, 2005, Kharchilava, Amiranashvili, 1988]. The visibility depends on many factors, including air pollution [Amiranashvili et al., 2010]. Therefore the study of a question of the representativeness of data of visibility for evaluating the atmospheric pollution is very interesting. In the work the results of investigating the correlation and regression connections between the average annual values of the surface ozone concentration and the number of days per annum with the range of the visibility of different intensity for 9,12 and 15 hours of observations are represented.

2. METHOD AND DATA DESCRIPTION

The measurements of the surface ozone concentration (Y) were conducted by the electro chemical ozone instrument OMG-200. Observational data for 15 hours are presented. In the proposed work the analysis of data is carried out with the use of the standard statistical analysis methods of random events and methods of mathematical statistics for the non accidental time-series of observations [Kendall, 1981; Kobisheva, Narovlianski, 1978].

The unit of the ozone measurement is omitted below (mcg/m^3). The data of the Hydrometeorological department of Georgia about the number of days per annum with the visibility of different intensity for 9,12 and 15 hours of observations are used. The following designations will be used below: V(9) - the number of days per annum with the visibility of 9 point in scale, V(6+5) - the number of days per annum with visibility 6 and 5 point in scale, etc., R - coefficient of linear correlation, R^2 – coefficient of determination, K_{dw} – Durbin-Watson statistic, α - the level of significance.

Table 1. Gradations of the meteorological visibility on the point in scale

Point in scale	Distance to object (km)		Point in scale	Distance to object (km)	
	Object is visible	Object is not visible		Object is visible	Object is not visible
0		Less 0.05	5	2	4
1	0.05	0.2	6	4	10
2	0.2	0.5	7	10	20
3	0.5	1	8	20	50
4	1	2	9	More 50	

The observation period – 1984-2008. The gradations of the meteorological visibility on the point in scale in table 1 are presented [Sternzat, 1978].

3. RESULTS

The results in table 2 and fig. 1-4 are given.

Table 2. The characteristics of correlation and regression of the number of days per annum with the visibility of different intensity for 9, 12 and 15 hours and surface ozone concentration (Y) for 15 hour in Tbilisi in 1984-2008

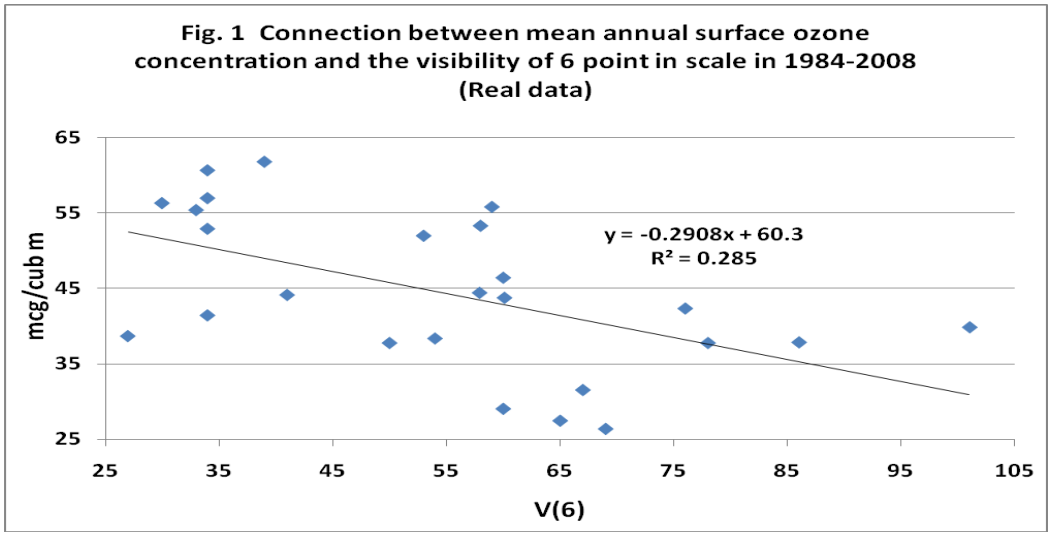
Parameters	Type of trend
V(9)	$Y = a \cdot x^4 + b \cdot x^3 + c \cdot x^2 + d \cdot x + e$ $R^2 = 0.32$, $K_{dw} = 1.36$
V(8)	No trend

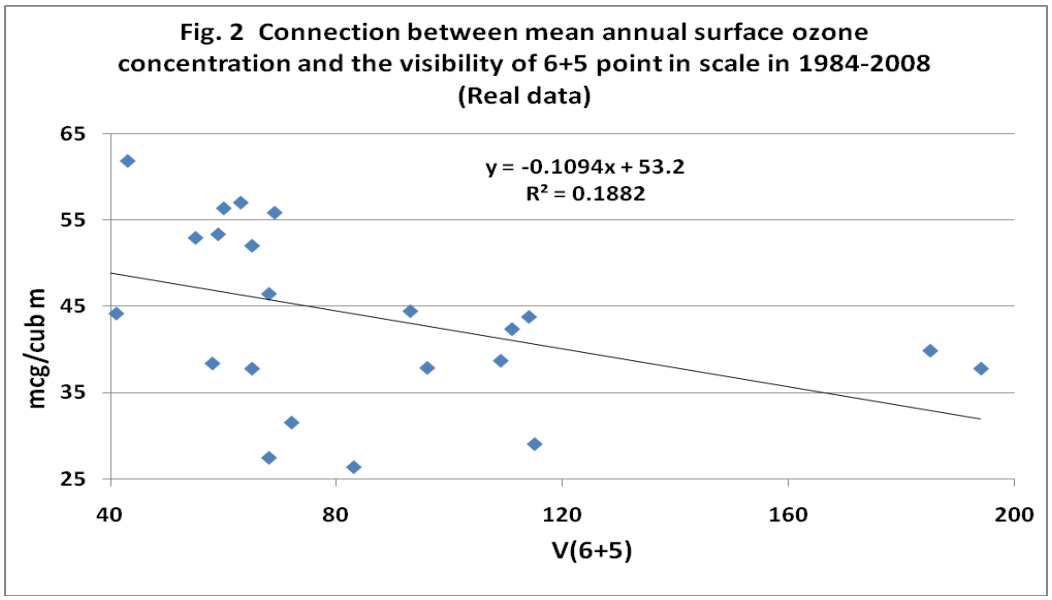
V(7)	$Y = a \cdot x^5 + b \cdot x^4 + c \cdot x^3 + d \cdot x^2 + e \cdot x + f$ $R^2 = 0.22$, $K_{dw} = 1.30$							
V(6)	No trend							
V(5)	$Y = a \cdot b^x$ $R^2 = 0.83$, $K_{dw} = 2.80$							
V(4)	No trend							
V(6+5)	$Y = a \cdot x^b$ $R^2 = 0.66$, $K_{dw} = 1.93$							
V(5+4)	$Y = a \cdot x^b$ $R^2 = 0.78$, $K_{dw} = 1.91$							
Ozone	$Y = a \cdot x^4 + b \cdot x^3 + c \cdot x^2 + d \cdot x + e$ $R^2 = 0.83$, $K_{dw} = 2.03$							
	Correlation matrix							
	V(9)	V(8)	V(7)	V(6)	V(5)	V(4)	V(6+5)	V(5+4)
	Real data							
Ozone	0.28	-0.29	0.01	-0.53	-0.25	-0.15	-0.43	-0.26
(α) R	0.15	0.15	-	0.01	0.15	0.45	0.05	0.15
	Residual							
Ozone	0.32	-0.37	-0.25	-0.05	0.28	-0.04	0.11	0.24
(α) R	0.10	0.10	0.15	-	0.15	-	0.75	0.15
	Multiple linear regression between mean annual surface ozone concentration (Y) and the number of days per annum with the visibility of 6+5 point in scale. X1 - the visibility trend+background component, X2 - the visibility residual component							
	$Y = -0.06678 \cdot X1 - 0.1925 \cdot X2 + 54.29$ $R^2 = 0.24$							
Share (%)	X1		21.3		X2		42.0	

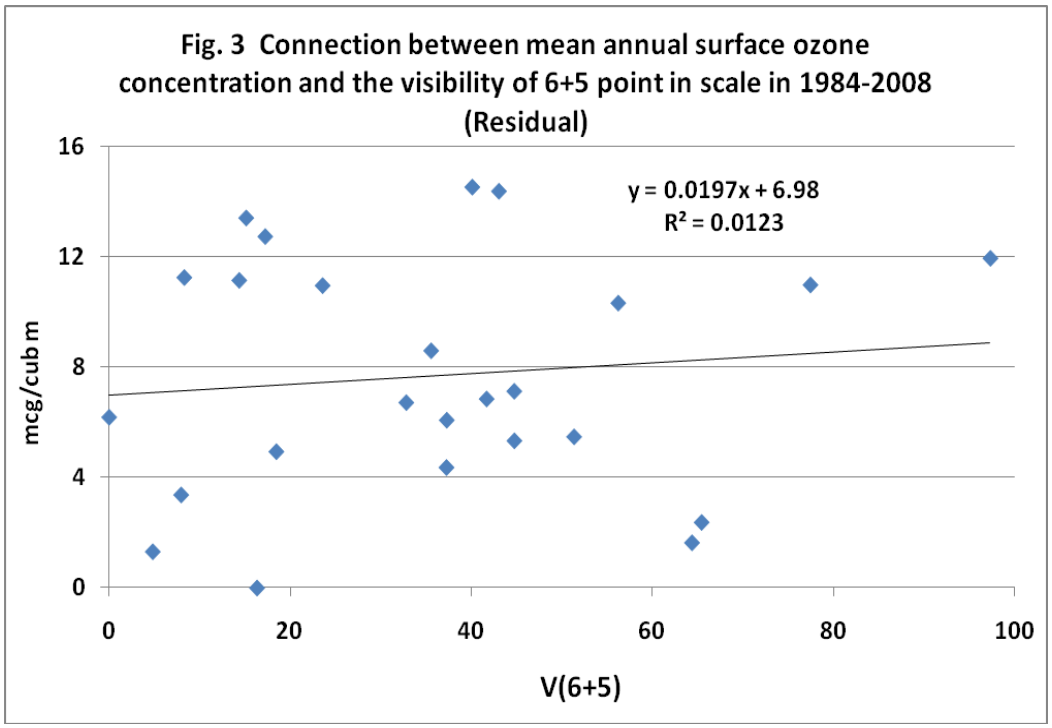
In the upper part of table 2 the data about characteristics of changeability of mean annual surface ozone concentration and number of days with the visibility of different intensity are presented. As follow on this table the time-series of V(8), V(6) and V(4) do not have trend. All trends of the remaining indicated parameters have a nonlinear nature.

Between the measured values of Y and V the values of the linear correlation coefficient changes from 0.28 (pair Y - V(9)) to -0.53 (pair Y - V(6)). For random components the values of the correlation coefficient change from -0.37 (pair Y - V(8)) to 0.32 (pair Y - V(9)).

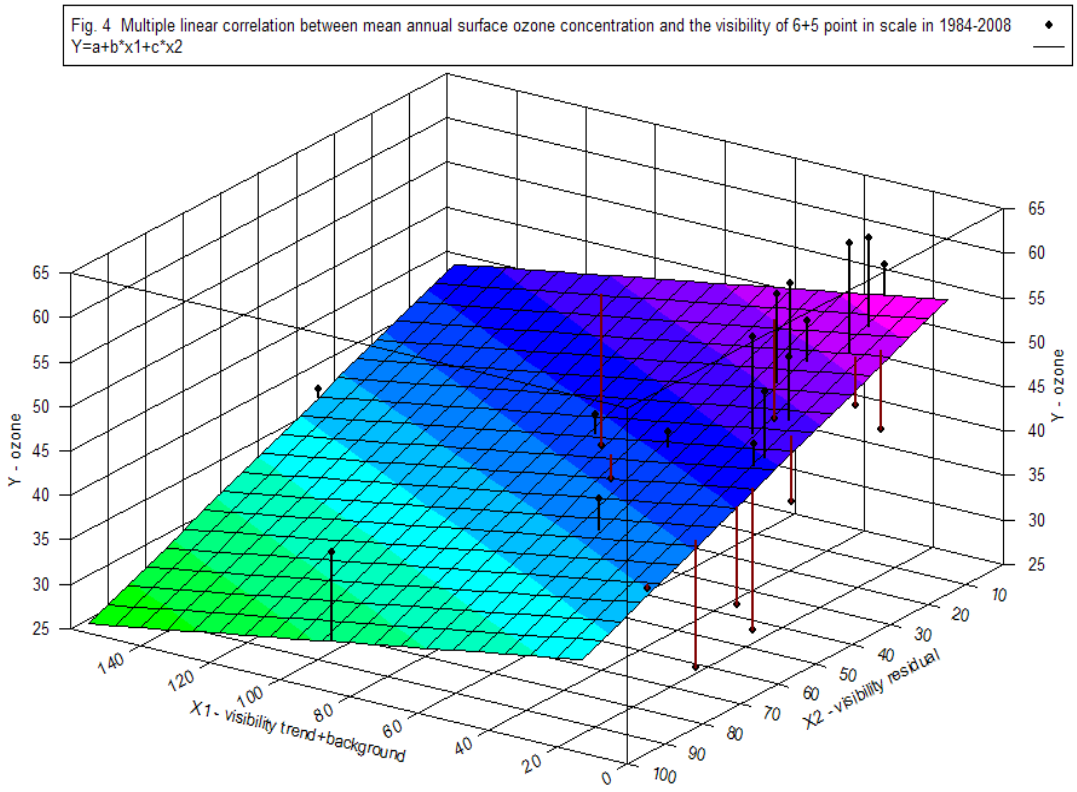
It is interesting to note, that values of R for pairs Y-V(9) and Y-V(8) are approximately identical with respect to value and sign both for real data and for the random components. Correlation between Y and V(7) for real data is not observed, whereas for the random components it is equal to -0.25. For pairs of Y-V(6), Y-V(4) and Y-V(6+5) vice versa - correlation between real data is observed, but for random components is not observed. Correlation for pairs Y - V(5) and Y - V(5+4) both for real data and for the random components is observed, but has opposite sign. The analysis of the reasons of indicated correlation between surface ozone concentration and the number of days with the visibility of different intensity is an object of further experiments.







In the low part of table 2 and fig. 4 multiple linear regression between mean annual surface ozone concentration and the number of days per annum with the visibility of 6+5 point in scale are presented. As follows from this equation the changeability of ozone concentration mainly depends on the changeability of residual component of V(6+5) (42 %), and less - on the changeability of the visibility trend+background component (21 %).



As a whole the obtained results make it possible to make a conclusion about the representativeness of the data about the range of visibility as the indirect characteristic of the level of the atmospheric pollution.

4. CONCLUSIONS

The results of investigating the correlation and regression connections between the average annual values of the surface ozone concentration and the number of days per annum with the range of the visibility of different intensity are represented. It is shown, that as a whole the obtained results make it possible to make a conclusion about the representativeness of the data about the range of visibility as the indirect characteristic of the level of the atmospheric pollution.

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ხილვადობის სიშორის კავშირი მიწისპირა ოზონის კონცენტრაციასთან თბილისში

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რეზიუმე

მიწისპირა ოზონის კონცენტრაცია წარმოადგენს ატმოსფეროს დაბინძურების დონის პირდაპირ მახასიათებელს. მეტეოროლოგიური ხილვადობის სიშორე მრავალ ფაქტორზეა დამოკიდებული, მათ შორის ჰაერის დაბინძურებაზეც. ამიტომ გარკვეულ ინტერესს წარმოადგენს ხილვადობის სიშორეზე მონაცემების რეპრეზენტატულობის საკითხის შესწავლა ატმოსფეროს დაბინძურების შეფასებისათვის. სამუშაოში წარმოდგენილია მიწისპირა ოზონის საშუალოწლიური მონაცემები (Y) და სხვადასხვა ბალიანობის ხილვადობის სიშორის მქონე დღეების რიცხვს (V(9), V(6+5) და ა.შ.) შორის კორელაციური და რეგრესიული კავშირის გამოკვლევის შედეგები 9, 12 და 15 საათზე დაკვირვებებისათვის. გამოყენებულია 1984-დან 2008-წლამდე მონაცემები.

დაკვირვებათა ყველა მწკრივისათვის წინასწარ განსაზღვრულია ტრენდები (თუ ის არსებობს) და შემთხვევითი მდგენელი. მიღებულია, რომ Y და V გაზომილ მნიშვნელობებს შორის კორელაციის წრფივი კოეფიციენტის მნიშვნელობა იცვლება 0.28-დან (Y -V(9) წყვილისათვის) – 0.53-მდე (Y-V(6) წყვილისათვის). შემთხვევითი მდგენელისათვის კორელაციის კოეფიციენტის მნიშვნელობა იცვლება -0.37-დან (Y-V(8) წყვილისათვის) – 0.32-მდე (Y-V(9) წყვილისათვის). მიღებული შედეგები საშუალებას იძლევა გავაკეთოდ დასკვნა ხილვადობის სიშორის მონაცემების რეპრეზენტატულობაზე, როგორც ატმოსფეროს დაბინძურების დონის არაპირდაპირ მახასიათებელზე.

საკვანძო სიტყვებია: ხილვადობა, მიწისპირა ოზონის კონცენტრაცია, ჰაერის დაბინძურება.

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