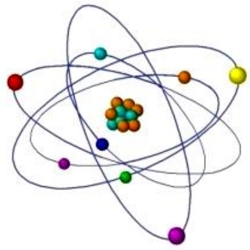
CONNECTION OF SUM LIGHT AEROIONS CONCENTRATION WITH NATURAL GAMMA RADIATION AND AIR TEMPERATURE IN WESTERN GEORGIA



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ABSTRACT: *Results of investigation of connection of sum light aeroions concentration (N) with environmental gamma radiation (Γ) and air temperature (T) in western Georgia are presented.Simultaneous measurements of N, Γ and T were madeat 166 different points by using portable aeroions, gamma and temperature survey meters.The terrain height (H) varied from 6 to 1928 m above sea level.The statistical characteristics of the values ofN, Γ and Thave been studied. In particular, the following results were obtained. Range of changes of investigation parameters is following:N – 450÷3100 sm^{-3}, Γ - 40÷180 nSv/h, T - 10÷34 ˚C. Mean values: N – 1898 sm^{-3}, Γ - 80 nSv/h, T – 24.6 ˚C.Coefficient of linear correlation (R) of individual values of N with Γ, T and H accordingly are: 0.08 (level of signification α=0.25), 0.30 (α<0.005) and 0.12 (α=0.10). It is absent correlation between Γ and T.A multiple linear regression equation N with Γ, T and H is obtained.In particular, the variability of the individual N values with the variability of other studied parameters within the variation range is as follows (166 different pointsof measurements): Γ–6.9 %, T – 61.0 % and H – 47.1 %. Thus, the main factor in the variability of the content of light air ions in this case is not the ionizing effect of gamma radiation from the soil, but the air temperature (variability of radon emanation from the soil) and the height of the terrain (variability of cosmic radiation). Connection of the averaged values of N on the Γ has the form of a linear function: N = 2.9228·Γ + 1671.2 (R = 0.96, α<0.005).*

Key words: environmental gamma-radiation, natural radioactivity, light Ions

INTRODUCTION

The light ions concentration in the atmosphere in many respects defines the ecological state of medium both itself and being the indicator of the purity of air in the aspect of aerosol pollution [1-5].

The content of light ions in the atmosphere plays the significant role in molding of the physiological state of people [6-9]. Under the "good weather" condition, the minimally necessary level of the sum light ions content for the favorable influence on the health of people is ≈1000 cm^{-3} and more. If the sum light ions concentration is ≈600 cm^{-3} and less, the following negative physiological action on the human organism are observed: fatigue, weakening attention, retarding of reactions, worsening in the memory, headache, the disturbance of the regime of blood pressure, etc. Air, saturated by the high content of ions (4500 cm^{-3} and more), possesses therapeutic properties - optimization of blood pressure, positive influence on the course of the diseases of respiratory organs, bronchial asthma, antiseptic action, etc. The very high concentrations of light ions (100000 cm^{-3} and more) negative affect the health of people [1, 10, 11].

The formation of light ions in the ground layer of the atmosphere occurs due to the alpha radiation of radon and short-lived products of its decay (40 %), gamma-radiation of soil (40 %) and cosmic rays (20 %). The disappearance of ions occurs due to their recombination and attachment to the aerosols. Usually the concentration of light ions always directly depends on the intensity of the ionizing radiation [12].

Atmospheric aerosol is the mixture of the usual particles of the natural and anthropogenic origin (mineral aerosol, sea aerosol, the solid ejections of industrial enterprises and transport, etc.) and the so-called secondary aerosol. Secondary aerosol is formed in the presence of the chemical and photochemical reactions according to the scheme of gas→ particle. However, it turned out that radioactive (including gamma radiation) and cosmic radiation contributes to the acceleration of the processes of the secondary aerosol formation [1,2 4,5, 13-16].

Therefore, in highly polluted areas, instead of direct the feedbacks between ionizing radiation and the content of light ions in the air may appear. For example, in Tbilisi city according to the data of the complex monitoring of small ions concentration, radon, aerosol, cosmic rays and gamma-radiation the effect of feedback of intensity of ionizing radiation with the small ions content in atmosphere is discovered. One of the reasons for this effect just may be catalyzation of the processes of formation secondary aerosols in atmosphere according to the scheme of gas→ particle by the ionizing radiation, which occur more intensive than the ions formation [1,2, 4, 5].

In particular, a comparison of the influence of gamma radiation on the content of light ions in twenty points of Tbilisi city and an ecologically cleaner atmosphere in western Georgia (111 points, height range from 100 to 500 m above sea level) showed that the correlation between Γ and N in Tbilisi is inverse, and in western Georgia, as it should be, is direct correlation [1, 2].

In addition to the above-mentioned ionized radiation and aerosol air pollution, the content of light ions is influenced by many other factors: weather conditions, terrain, places with waterfalls, fountains, national parks, nature reserves, forests, alpine regions, mountain gorges, river and sea coasts, tectonic faults (increased concentration of radon), karst caves, etc. [1, 6, 8, 9, 17, 18].

So in [18] the data about the content of aeroions in Tbilisi and some locations of Western Georgia with different types of landscape are represented. In particular, it is shown that even in the limits of the strongly contaminated city the landscape has vital importance for creating the medium ecologically favorable for human health (Tbilisi National Botanical Garden, territory of Tbilisi Sea, etc.). Therefore, variations in the content of light ions in the air often depend more on some listed factors (weather conditions, landscape, hydroionization, phytoionization, etc.) than on direct alpha, beta, gamma and cosmic radiation.

This work is a continuation of the study [2].Results of investigation of connection of sum light aeroions concentration with environmental gamma radiation and air temperaturein western Georgia are presented below.

STUDY AREA, MATERIALS AND METHODS

Study area – western Georgia. Measurement of values of gamma radiation was made on ~ 20 cm above the ground surface, sum aeroions concentration and air temperature measured on ~ 1.0 m above the ground surface.The portable survey meters were using [1-5,18,19].Simultaneous measurements of investigation parametersin 2007-2008 at 166 different pointswere made (fig. 1).The terrain height varied from 6 to 1928 m above sea level.

In the proposed work the analysis of data is carried out with the use of the standard statistical analysis methods of random events [20].

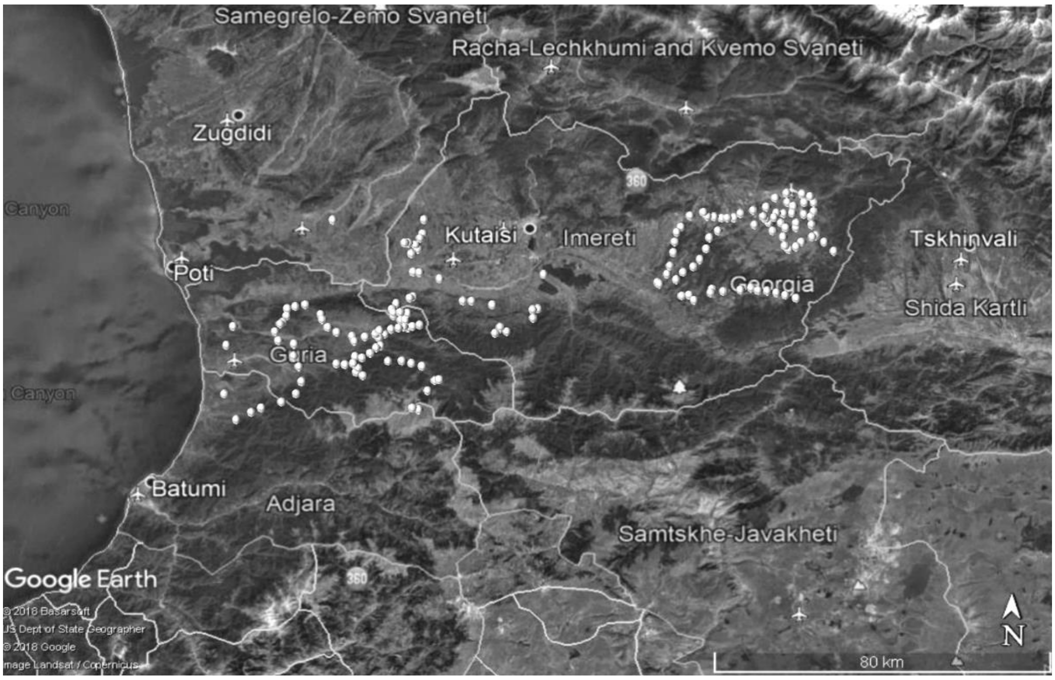

Fig. 1. Location of measurement points in western Georgia.

The following designations will be used below: Mean – average values; Min – minimal values; Max - maximal values; Range – Max-Min; St Dev - standard deviation; C_V = 100·St Dev/Mean – coefficient of variation, %; R^2– coefficient of determination;R – coefficient of linear correlation;α - the level of significance; N – sumaeroions concentration, cm^{-3}; Γ- value of gamma radiation,nSv/h; T - air temperature, ˚C; H - terrain heightabove sea level, meter.

RESULTS

The results in table and fig. 2 are presented.

In table the statistical characteristics of Γ, T, H and N in western Georgia are presented.

Table. Statistical characteristics of Γ, T, H and N in western Georgia.

Variable	Γ, nSv/h	T, C°	H, m	N, cm^{-3}
Mean	80	24.6	341	1898
Max	180	34	1928	3100
Min	40	10	6	450
Range	140	24	1922	2650
St Dev	25.3	4.46		547
Cv,%	31.8	18.1		28.8
	Correlation Matrix			
Γ, nSv/h	1	-0.004	0.44	0.08
T, C°	-0.004	1	-0.35	0.30
H, m	0.44	-0.35	1	0.12
N, cm^{-3}	0.08	0.30	0.12	1

As follows from table range of changes of investigation parameters is following: N – 450÷3100 sm^{-3}, Γ - 40÷180 nSv/h, T - 10÷34 ˚C. Mean values: N – 1898 sm^{-3}, Γ - 80 nSv/h, T – 24.6 ˚C. The largest variations are noted for the values of Γ(Cv=31.8%), the smallest - for T(Cv=18.1%). Coefficient of linear correlationof individual values of N with Γ, T and H accordingly are: 0.08 (α=0.25), 0.30 (α<0.005) and 0.12 (α=0.10). It is absent correlation between Γ and T.

It should be noted that for an altitude range of 100-500 m above sea level (111 measurement points) the linear correlation between Γ and N is higher (R=0.27, α<0.005) [2] than in this case (an altitude range from6 to 1928 m, 166 measurement points). Nevertheless, a positive correlation between these parameters remains.

A multiple linear regression equation N with Γ, T and H is presented below:

$$N = -0.939 \cdot \Gamma + 48.244 \cdot T + 0.465 \cdot H + 627.86 (R^2 = 0.147, \alpha<0.005)$$

The variability of the individual N values with the variability of other studied parameters within the variation range is as follows (166 different points of measurements): Γ – 6.9 %, T – 61.0 % and H – 47.1 %.

Thus, the main factor in the variability of the content of light air ions in this case is not the ionizing effect of gamma radiation from the soil, but the air temperature (variability of radon emanation from the soil) and the height of the terrain (variability of cosmic radiation).

In fig. 2 linear correlation and regression between averaging values of N and Γ is presented.

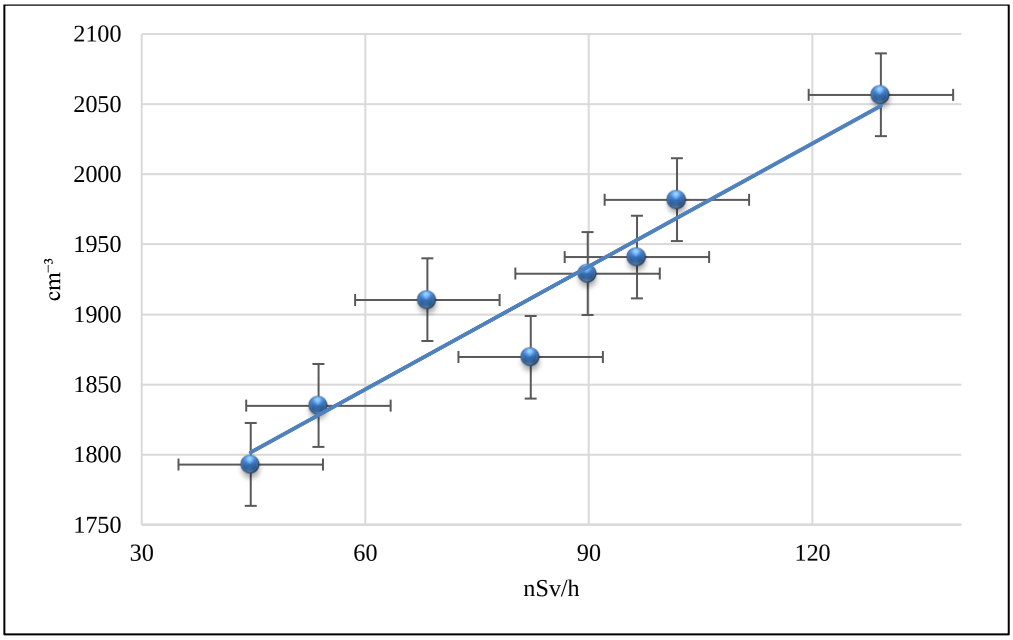

Fig. 2. Linear correlation and regression between averaging values of N and Γ.

In this case connection of the values ofN on the Γ connection is very close:

$$N = 2.9228 \cdot \Gamma + 1671.2 \ (R = 0.96, \alpha<0.005).$$

Thus, when averaging the data, the relationship between Γ and N is revealed more clearly (fig. 2) than in the case of correlating their individual values (table). Apparently, in this case, the effects of temperature and altitude in the variability of the concentration of light ions are leveled.

CONCLUSION

In the future, we plan conduct more detailed studies in this direction for different regions of Georgia.

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