Journal of the Geophysical Society,
Issue B. Physics of Atmosphere, Ocean and Space Plasma, v 20B, 2017, pp.73-87

Boleslovas Styra. 105 Years from the Birthday. His Role in the Formation, Development and Modern Evolution of Nuclear Meteorology in Georgia

Avtandil G. Amiranashvili

Iv. Javakhishvili Tbilisi State University, M. Nodia Institute of Geophysics,
1, Alexidze Str., 0160, Tbilisi, Georgia, e-mail: avtandilamiranashvili@gmail.com

ABSTRACT

The work is dedicated to the memory of Boleslovas Styra, an outstanding Lithuanian scientist, founder of new direction of atmosphere physics - nuclear meteorology. His role in the formation, development and the modern evolution is noted of this direction of science in Georgia.

Key words: Nuclear meteorology, atmospheric radioactivity.

Boleslovas (Balys) Styra

Date of Birth: *September 9, 1912 - February 12, 1993*
Place of birth: *Leningrad (St. Petersburg)*
Activities: *Habilitated Doctor of Geophysics, Physics and Mathematics, Professor, Corresponding Member of the Lithuanian Academy of Sciences,*
Twice Laureate of the State Premium of Lithuania
Honor: *Memorial Board (Vilnius City, Paneriai Subdistrict / Paneriai)*

Boleslovas (Balys) Styra was born in St. Petersburg (Russia), a family of Lithuanian emigrants. In 1937 graduated from the Faculty of Physics at Leningrad State University (now St. Petersburg State University), worked as a teacher of physics and assistant of the Atmospheric Physics Department at the University.

During the Second World War, he was mobilized and took part in the defense of Leningrad. Worked in the Leningrad Front Hydrometeorological Service Board. In 1944 B. Styra returned to Lithuania. He was appointed director of the Kaunas Geophysical Observatory. In 1946-1963 he worked as a senior researcher at the Institute of Geology and Geography at the Lithuanian Academy of Sciences. He was the head of the Department of Atmospheric Physics of the Institute of Geophysics since 1952. And - Deputy Director for Scientific Work since 1957.

In 1947 he defended doctoral dissertation on physics and mathematics at Kaunas State University. He taught high mathematics at the Lithuanian Academy of Agriculture (now Aleksandras Stulginskis University) in Kaunas in 1947-1957.

In 1947-1964 worked at Vilnius University. In 1953-1960 he was the Meteorology of the Vilnius University, Head of Department of Hydrology and Climatology since 1961. During the reorganization of educational institutions, B. Styra's work and duties were changed several times.

In 1963-1965 he worked at the Botanical Institute (now the Botanical Institute of the Natural Research Center) as Head of Sector, from 1965 to 1967 – in Lithuanian Academy of Sciences (Head of the Department of Applied Nuclear Physics and Radioisotopes Application Bureau), in 1967-1977 - Deputy Director of the Institute of Physics and Mathematics and Head of the Department of Atmospheric Radioactivity, in 1977-1993 - Deputy Director and Head of the Division of the Institute of Physics [1-7].

B. Styra was the editor of the continuing scientific publication "Atmosphere Physics", scientific consultant of the "Lithuanian Soviet Encyclopedia” Since 1973. In 1953 B. Styra was awarded the Docent, in 1964 – was awarded the Professor's name.

In 1965 the researcher has been awarded the title of the honored worker of a science.

In 1976 he was elected as correspondent member of the Lithuanian Academy of Sciences, in 1980 the name of the Lithuanian Nature Conservation Label is given.

In 1983 the literature index "Boleslovas Styra = Болеслав Стыро" prepared by Senior Research Worker Ingos Blažienė, Institute of Labor and Social Research, Vilnius was published [1]. The index was published by the physicist, habilitated doctor of sciences Viktor Luciano in the Lithuanian and Russian languages, presents the main dates of life and activity of B. Styro**,** recorded in 1939-1981. Professor's scientific and scientific publications [http://www.vilnijosvartai.lt/personalijos/boleslovas-styra/].

Scientist died in 1993 February 12. He is buried in the Antakalnis Cemetery in Vilnius. 2007 September 28 in Vilnius, on the building of the Institute of Physics, Savanoriu pr. 231 (Paneriai eldership), commemorating the 95th anniversary of the birth of B. Styras, a memorial plaque unveiled to the scientist [5].

B. Styra's creative heritage consists of about 300 scientific articles. The main areas of scientific work are climatology, atmospheric radioactivity issues, research into radioactive contamination in the atmosphere [8]. He has written monographs "Voprosy yadernoy meteorologii" [9], “Yadernaya meteorologiya” [10], "Samoochishcheniye atmosfery ot radioaktivnykh zagryazneniy" [11]. There were publications of “Radioaktivnost' atmosfery i meteorologiya” [12], “Geophysical problems of krypton-85 in atmosphere” [13], “Izotopy ioda i radiatsionnaya bezopasnost'” [14] (all Russian books). For scientific works B. Styra in 1959 and 1975 the Lithuanian State Premium were awarded [1-7].

B. Styra was the creator of the new direction of atmosphere physics – “nuclear meteorology” [9,10,15-17], that designates number of the problems of the study of the radioactivity of the atmosphere in connection with the meteorological processes, proceeding in it. It notes that artificial radionuclides can be used as the tracers for studying the motion of air masses.

The creation of this direction preceded the significant number of works of B. Styra, his Lithuanian associates and scientists from other countries on a study of the atmosphere radioactivity [8]. It was in particular noted that the atmosphere is the medium, where the process of appearance and of decomposing the radioactive isotopes continuously continues; it was assumed that the air composition is not constant and that its continuous fluctuations – law of the life of the atmosphere; it was indicated that further studies in this direction will lead to the discovery of a new number of reactions and transformations of the air substance in atmosphere. The great attention was paid to the possibility of substantial changes in the composition of atmospheric air under the effect of the space and radioactive radiation. It was indicated the prospect of the using a natural and induced activity of air, as the tracers for studying the dynamics of air masses, atmospheric turbulence, different microphysical and dynamic processes, which take place in clouds and etc. The need for the intensification of studies to discover the role of atmospheric radioactivity of its total ionic balance, in the formation and development of precipitations, etc., was noted.

At the end of June the beginning of July 1960 in Vilnius was conducted the conference on actinometry questions, atmospheric optics and nuclear meteorology, which was called by the institute of geography and geology of Lithuanian academy science together with the radiation subcommittee and the commission atmospheric physics of the Science Soviet Academy, by the administration for the hydrometeorological service of USSR and by the establishments of the ministry of higher education of

USSR. In the work of the section of nuclear meteorology was accepted the participation more than 70 representatives from different scientific organizations. Review on the theme the "Basic Problems of Nuclear Meteorology" was read by B. Styra. It was separately noted in the report, that strongly enlarged studies of radioactive phenomena in the atmosphere give possibility all questions, connected with these phenomena, to isolate into separate independent discipline "Nuclear Meteorology". The basic tasks of this discipline and the possible methods of their solution were designated in the report [15]. Practically, at this conference the term "Nuclear Meteorology" was legally designed.

Studies of the natural radioactivity environment in Georgia have been conducted for a long time. The determination of the content of radioactive elements in the waters of Georgia is conducted since 1912 (mainly the radioactive elements of the uranium series: uranium, radium and radon). At the end of the Thirties of past century these works of the institute geophysics were continued, and was including a study of rock radioactivity, [18-23].

At the end of the Thirties of past century the work was begun in the institute of geophysics on the investigation the rock radioactivity and mineral sources in the territory of Georgia. In this direction was studied the content in them of radium, elements of the group of uranium, its salts and emanations [18-23]. Later, in the Sixties of past century began works, with the active participation of Lithuanian scientists (Styra B., Vebra E., Sopauskas K., etc.), to the direction of nuclear meteorology [24-28]. For the first time in Georgia with the use of a aircraft laboratory were studied the vertical profiles of the short-lived decay products of radon in the lower five-kilometer layer of the atmosphere, the estimations of turbulence factor according to these profiles were carried out. On the basis of the data about the content of the decay products of radon in the drops of clouds were carried out the estimations of the coagulation values coefficient of cloud drops with the solid particles [24-28].

In the seventieth-eightieth years of past century these works were significantly enlarged [29-38]. In this case special attention was given to a study of the natural radioactivity of cumulus clouds, to the determination of different microphysical and dynamic characteristics of clouds according to the data about their natural radioactivity [30-38]. Together with this was studied also the content of nonradioactive aerosols with a diameter of more than 0.7 µm in free-atmosphere conditions and clouds [37,38].

So, in the work [33], aircraft sounding of cumuli clouds in the eastern regions of Georgia during 1973-1977 about 70 vertical distribution profiles of radon decay products α-radioactivity for cloud drops and 50 profiles for the cloud medium were obtained. It was determined that in cumuli in a developed phase there exist 4 types of natural radionuclide vertical distribution. It was established that the accumulation of natural radioactivity takes place mainly in the lower part of the cloud, incidentally the radionuclide accumulation level appears to grow with the cloud power. The radioactivity of cloud drops on the average decreases greatly with height in the lower part of the cloud, and in the middle and upper parts it changes vertically insignificantly. The value of the specific radioactivity of the cloud water in different parts of the cloud varies on the average from $(4.4\pm0.9)\cdot10^{-10}$ up to $(1.2\pm0.2)\cdot10^{-10}$ Ci/g. The parameter of the nonradioactive removal of radioactive aerosols by drops and the effective rate of the vertical air current in cumuli clouds were calculated. Estimation of the radon current through the cloud bottom was performed.

There are presented the results of the investigation natural radioactivity in cumuli at different phases of their development [34]. It has been established that in the process of the development of clouds general accumulation of radioactivity takes place, which in the developed period mounts to the values sometimes exceeding $1\cdot10^{-7}$ Ci/m^2, and subsequently the decrease of the radioactivity is observed. In all the experiments concentration of the radioactive substances decreased with height. After the artificial destruction of the cloud "radioactivity track" still exists for about 20 min with the subsequent dispersion. The estimations of the coefficient of nonradioactive removal of radioactive aerosols and the rates of vertical currents during different phases of clouds have been performed. It was shown that the coefficient of nonradioactive removal of radioactive aerosols is higher in the process of growth and approximately by 30% lower in the period of cloud disintegration.

A nonstationary equation of vertical distribution of natural radioisotope aerosols in cumuli, assuming the constant velocities of up-currents with the absence of the side drawing, is solved [32]. It is presented The equation, describing vertical radioactivity distribution on cloud drops. These equations make it possible to determine the distribution of nonradioactive aerosols in cloud air. The data received show the cloud radioactivity to very sufficiently up to one third of its height and subsequently remaining the same, while nonradioactive aerosol concentration decreases significantly more. Vertical distribution profiles of radioactive and nonradioactive aerosols coincide in general, but nonradioactive aerosols with the run of time accumulate in larger amounts. Aerosol accumulation, at nonradioactive removal coefficient being constant, depends sufficiently upon the velocity of up-currents. Aerosol accumulation grows together with the nonradioactive removal coefficient. The obtained distribution profiles of radioactive and nonradioactive aerosols have analogous character and coincide with the experimental ones within the limits of measuring error.

Under the leadership of B. Styra in institute of geophysics of Georgian academy of sciences two Ph.D. dissertations were defended:

Khundzhua T.G. – Nekotoryye rezul'taty samoletnykh issledovaniy raspredeleniya yestestvennoy radioaktivnosti v nizhney polovine troposfery, (1968)

Amiranashvili A.G. – Issledovaniya yestestvennoy radioaktivnosti kuchevykh oblakov, (1978)

The combined analysis of the aircraft experiments of aerosols in the atmosphere and clouds was carried out in the monograph [38]. In particular, there were given the data about the influence of convective cloudiness on the content of radioactive and nonradioactive aerosols in the atmosphere (table 1). As it follows from this table content of the aerosols of all types in the cloudless atmosphere lower than with the presence of cloudiness. The height of the layer of the atmosphere is 5 km for the radon decay products, and 3 km - for the nonradioactive aerosols.

Table 1

Content of natural radioactive and nonradioactive aerosols in the column of atmospheric air with a single cross-section in cloud days with comparison to the cloudless days (%)

Radon decay products	Calcium	Lead	Aerosols in different ranges of sizes, a radius - μm			Optical measurements of aerosols, a radius - μm	
			0.35÷1.0	1.0÷2.0	>2.0	0.1÷1.0	>1.0
133	104	147	121	113	200	124	193

It was also obtained that the value of the coefficient of nonradioactive removal of radioactive aerosols by cloud drops Λ, the effective upwash velocity of air in the cumulus clouds W, the speed of the flow of radon through the unit of the area of lower cloud base E_r depend on the vertical extent of the clouds H (H from 600 to 1800 m):

$$\Lambda = (9.6 \cdot H - 1)\cdot 10^{-4}\ sec^{-1}$$

$$W = (0.38 \cdot H - 0.12)\ m/sec$$

$$E_r = 0.5\cdot(0.38 \cdot H - 0.12)\cdot 10^{-10}\ Ci/m^2$$

Besides aircraft studies of the radon decay products in the atmosphere, similar works were conducted both in surface boundary layer [18,39,40] and also in air of karstic caves [18,41-44].

Preliminary studies of radon in the human habitat in different regions in Georgia (habitable and public rooms, Tbilisi subway, etc.) were carried out in 2001-2002 [45-47].

Later there was realized in Georgia the large-scale monitoring of radon in the soil, drinking water and air of apartment houses; were built the maps of the distributions of radon in the indicated media; the connections of the content of radon with the metastasis of lung cancer were revealed; also recommendations were given regarding the protection of population from the dangerous levels of the content of radon. The chemical composition of drinking water simultaneously was studied, were conducted the measurements of the gamma-radiation of soil and walls of the rooms of the houses, content of light ions, meteorological parameters, etc. [48-52]. Traditionally were examined the general problems of radiology [53,54].

Studies of radon not only as the tracer of different atmospheric processes, but of processes, which take place in the earth's crust (prognostication of earthquakes, etc.) and the hydrosphere are carried out [55-64].

Enumerated above works were carried out in the correspondence with the traditional concept of nuclear meteorology (common analyses of the natural radioactivity of environment; the use of radioactive isotopes as the passive tracers of different processes, which take place in the earth's crust, hydrosphere and atmosphere; study of ionizing emissions from the point view of action to the health of people, etc.).

Additionally, to the indicated works, in the recent two decades in the institute of geophysics are conducted studies of the natural ionizing emissions as the active components of the atmosphere, the capable of changing or of modifying its different properties (in our case - microphysical and electrical characteristics of clouds, formation of secondary aerosols, etc.). Push at the beginning of these studies, in particular, were works [65-67]. Thus, there was shown in the work [65] that the freezing point of the radioactive drops of water is higher than nonradioactive; There was revealed in the work [66] the role of radon as the accelerator of the formation of condensation nuclei. Effects of radioactive fallout on increasing of lightning frequency after Chernobil catastrophe studied in [67].

It should be noted that the general prospects for the studies of natural radioactivity as the active component of different processes taking place in the atmosphere, to the author of this work had luck to discuss with B. Styra, who even at the end of the fifties of past century indicated the importance of the similar studies [8].

Thus, here were represented some results of studies of the connection of beta radioactive fallout with the thunderstorm and hail activity of clouds in Georgia [68,69]. In work was study [68] the role of artificial ice forming reagents and radioactive intermixtures in the variation of convective clouds thunderstorm and hail activity. According to Dusheti data mean monthly daytime intensity of thunderstorm discharges is in direct correlation with a thunderstorm day duration and a value of beta-radioactive fall-out, and in inverse correlation with atmosphere aerosol pollution (correlation coefficients are equal to 0,62, 0.5 and -0,54 respectively) [69].

In work [70] it is shown, that under the condition of eastern Georgia radon and tropospheric ozone play important role in the formation of secondary aerosols. In particular, as follows from table 2, value of atmospheric aerosol optical depth (optical active aerosols) is directly connected with the summary content of radon in the five-kilometer layer of atmosphere. The correlation of radon with the large aerosol particles is insignificant (**R** – coefficient of linear correlation, **α** - level of signification).

Table 2

The statistical characteristics of the summary content of radon (**Q_{α},**) and aerosols with the diameter more than 0.7 mcm (**Q_a, 10^9 m^{-2}**) in the five-kilometer layer of atmosphere and atmospheric aerosol optical depth (**AOD**). Georgia, Kakheti region, aircraft and ground-based studies 1972-1977, 11 cases [70].

Parameter	**Q_a, 10^9 m^{-2}**	**Q_{α}, 10^3 Bq m^{-2}**	**AOD**
Mean	4.45	3.68	0.176
St Dev	1.08	1.62	0.046
Min	6.24	6.6	0.222
Max	3.1	1.11	0.042
Correlation Matrix			
Q_a. 10^9 м$^{-2}$	1	No sign	No sign
Q_{α}. 10^3 Бк м$^{-2}$	0.14	1	α = 0.1
AOD	0.21	R = 0.56	1

A scheme of the interaction of atmospheric aerosols and convective clouds and also generation in the atmosphere and clouds of condensation, crystallization nuclei and ice crystals with allowance to ionization and electrization processes occurring in the atmosphere has been proposed [71-73].

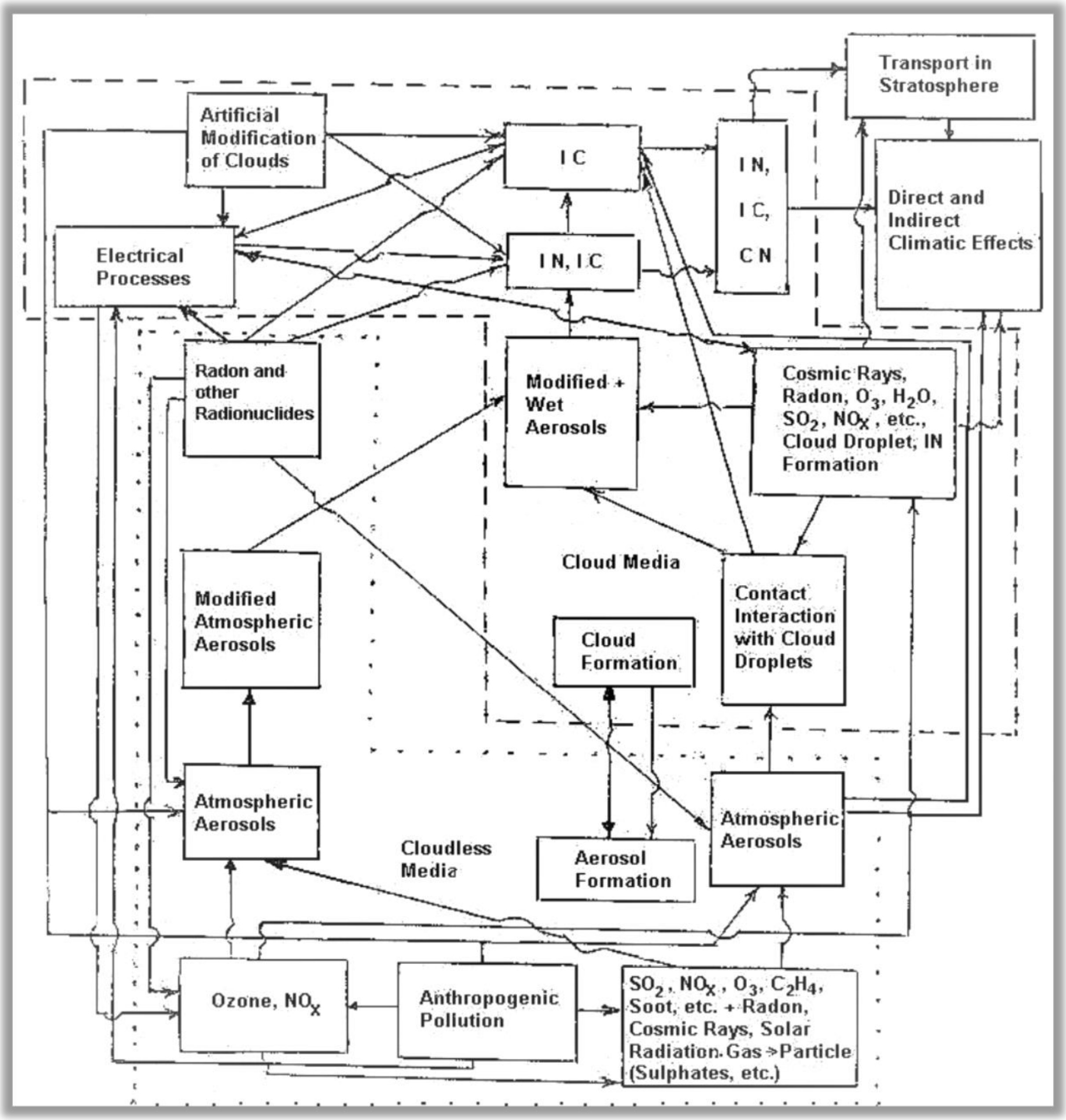

Fig. 1. Scheme of the convective clouds - aerosol interaction and formation of condensation and crystallization nuclei and ice crystals in the atmosphere and clouds. IN - ice nuclei; IC - ice crystals; CN - condensation nuclei

This scheme (fig. 1) shows how versatile the relations between processes in clouds and the clear atmosphere are. On one hand aerosols being modified in the atmosphere and getting into cloud media as a result of being humidified or interacting with cloud droplets conduce the generation of ice crystals. A change in the phase state of the cloud media leads to a change in its electric activity (cloud-to-cloud, intracloud, cloud-to-ground discharges). Discharging activity changes the chemical composition of the cloud media (formation of nitrogen oxides, ozone, etc.). The mentioned gases together with radon, sulphur oxides and other components under conditions of a high humidity and cosmic ionization lead to an intensive generation of condensation nuclei. Condensation of water vapour on these nuclei leads to local oversaturations, activation of inactive aerosols in the interdroplet media and generation of crystallization nuclei and ice crystals, i.e. again to a change in the phase state of the cloud media. At the same time the effect of high ozone concentrations on inactive soil aerosols in the interdroplet media activates them in the sense of the ice formation [38]. Phase transformations and ionization processes lead to changing of the electric activity of a cloud and the cycle repeats anew. Breaking through the troposphere strong vertical air flows can carry into the stratosphere considerable amounts of water vapour, aerosols, ozone, SO_2, NO_x and other admixtures. Thus cumulus, big convective and thunderstorm clouds in addition to direct climatic effects (solar radiation attenuation, precipitation, near-ground temperature changes, etc.) can considerably contribute to variations of the chemical composition of the atmosphere and the content of aerosols in it. The latter also affect radiative forcing and climate change.

In the last ten years was continued the study of the influence of the ionizing radiations (radon, gamma-radiation, cosmic rays) on the formation secondary aerosols in the atmosphere according to scheme gas→ particle. It is obtained that all types of the indicated ionizing radiations are the catalyst of the formation of sub-micron aerosols from the gases [74-84].

The special features of the effect of the radio nuclide emission in the formation of secondary aerosols in the conditions of Tbilisi city (Tbilisi type of smog) are revealed (table 3,4; fig.2,3).

Table 3

Linear correlation between radon content in air and some parameters of atmosphere in Tbilisi in 2009-2011 (daily average from 9 to 18 hour, R_{min} = 0.05, α = 0.07) [80]

T – air temperature; **U** – relative humidity; **P** – atmospheric pressure; **V** – wind speed; **O_3** - surface ozone concentration; **Rn** – radon content in air; **N** – concentration of submicron aerosols with diameter ≥0.1 mcm; **N(+/-)** – sum small ions content in air; **Q** – sum solar radiation intensity; **q** – intensity of galactic cosmic rays.

Parameter	T	U	P	V	O_3	N	N(+/-)	Q	q
Rn	-0.39	0.32	0.29	-0.36	-0.47	**0.43**	**-0.55**	-0.41	0.34

Table 4

Statistical characteristics of gamma-radiation of soil and content in air of radon, sub-micron aerosols and small ions in 20 locations of Tbilisi in 2009-2011 [80]

Parameter	Gamma-radiation of soil, nSv/hour	Radon, Bq/m^3	Aerosol, cm^{-3}	Sum ions, sm^{-3}
Average	81.9	6.3	3638	492
Min	53	1.4	750	200
Max	109	16.0	9000	1200
St Dev	10.9	3.0	1928	251
C_v	13.3	47.4	53.0	51.0
	Correlation matrix			
Gamma-radiation	1	0.37	0.24	**-0.15**
Radon	α = 0.05	1	0.70	**-0.51**
Aerosol	α =0.1	α = 0.0005	1	**-0.48**
Sum ions	α = 0.35	α = 0.001	α = 0.001	1

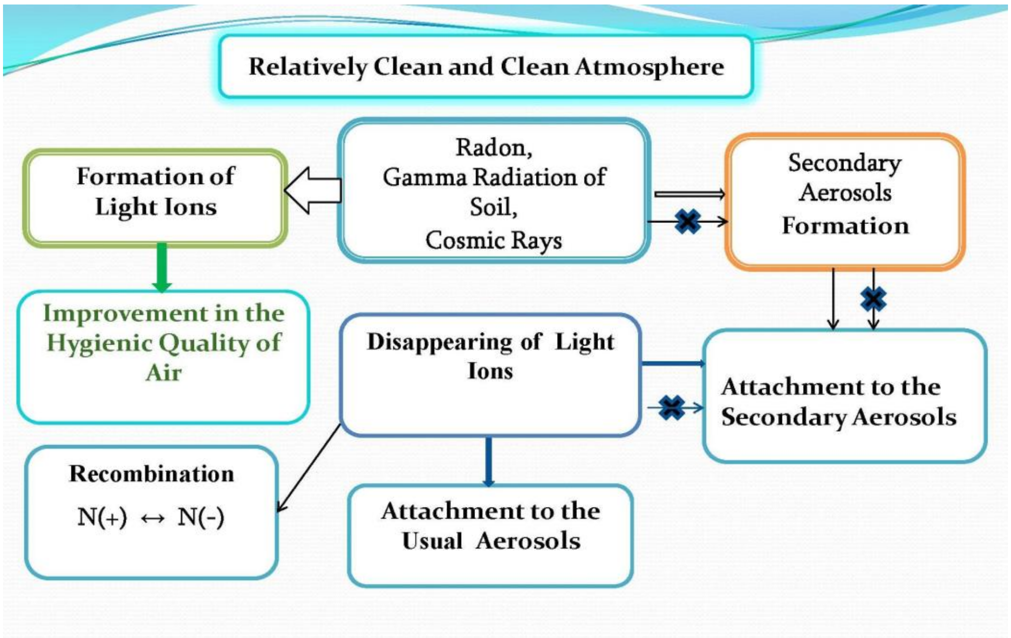

Fig. 2. Formation of secondary aerosols and of small ions in air under the effect of the ionizing radiation in the conditions of relative clean and clean atmosphere

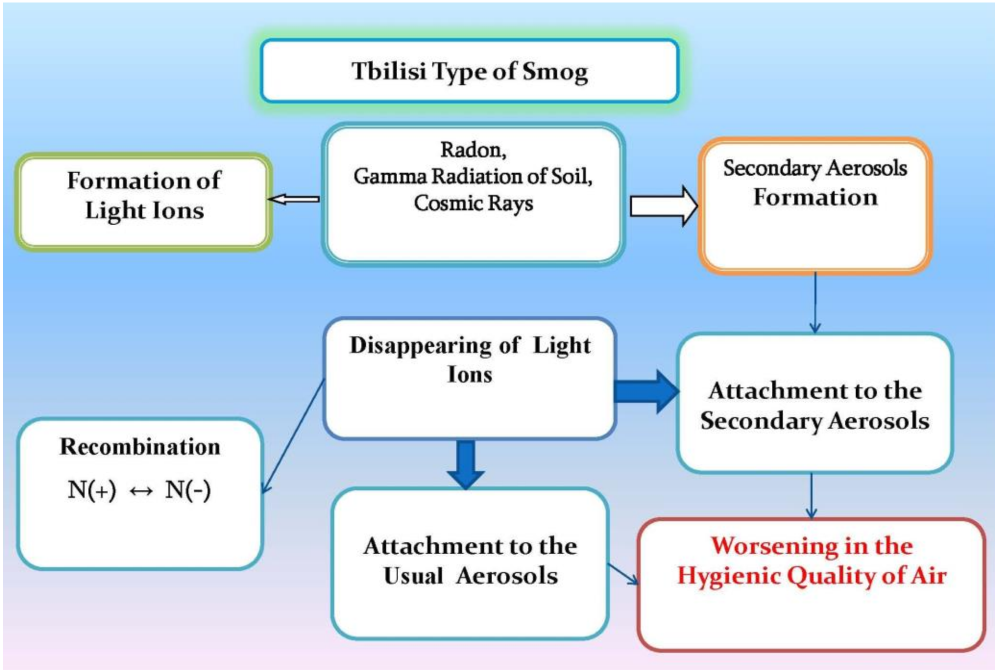

Fig. 3. Formation of secondary aerosols and of small ions in air under the effect of the ionizing radiation in the conditions of the strongly contaminated atmosphere (Tbilisi type of smog)

Intensification by the ionization of the aerosol pollution of the atmosphere under the conditions of Tbilisi is so strong which this leads also to worsening in the quality of air in the aspect of its ionic composition also. As a whole the Tbilisi type of smog is characterized by the impossible under the natural conditions feedback of the content of radon, gamma-radiation and cosmic radiation with the concentration of light ions in air, caused by the formation of secondary aerosols in the quantity, which in conjunction with the usual particles is capable of joining more ions to itself how them it is formed with the ionization [76-84].

The well-known balance equation relating the formation and disappearing of light ions **n,** taking into account the influence of the ionizing radiation on the formation of secondary aerosols, can take the form:

$$dn/dt = g - \alpha' \cdot n^2 - \beta \cdot S \cdot n - \beta' \cdot N(g) \cdot n$$

where: **g** is the intensity of ion formation, **α′**- recombination coefficient, **S** - usual aerosol concentration, **N(g)** – secondary aerosol concentration as **g** function, **β** and **β′** - coefficient of the capture of light ions by usual and secondary aerosols respectively. Depending on the nature of the connection between **g** and **N(g)** under the conditions of the strongly contaminated atmosphere (similar to Tbilisi) negative correlation between **g** and **n** is completely possible (fig. 2,3). So, Tbilisi type of smog can occur also in other strongly contaminated cities and environments.

In the locked spaces (living quarters, cave, mine, etc.) the high concentrations of radon create direct radiation exposure on the health of people [41-52]. In atmospheric air the direct radiation effects of radon for the health of people are completely insignificant because of their small concentrations.

However, in contaminated air an increase in radon leads to an increase in the content of secondary aerosols and the decrease of the concentration of light ions (i.e., to worsening in the quality of air, table 3,5; fig. 3). In the final - this is negative influences on the health of people (table 5).

Table 5

Linear correlation and multiple linear regression between daily (average from 9 to 18 hour) values of some atmospheric parameters and 24 hours' quantity of calls of fast medical aid (**A**) and the cases of hospitalization (**H**) in Tbilisi into 2009-2010 [80]

$$Y = a \cdot T + b \cdot U + c \cdot P + d \cdot V + e \cdot O_3 + f \cdot Rn + g \cdot N + h \cdot N(+/-) + i \cdot Q + j \cdot q + k$$

Parameter	T	U	P	V	O_3	Rn	N	N(+/-)	Q	q
I variant	**Correlation matrix** (**R** min = 0.14, **α** = 0.05), 211 cases									
A	-0.48	0.28	0.10	-0.19	-0.12	0.16	0.21	-0.09	-0.40	-0.57
H	-0.03	0.01	-0.17	-0.12	0.16	-0.06	-0.04	-0.17	0.02	-0.19
	For A, (Coefficient of determination R^2=0.579**; α** = 0.01); **For H, (R^2**=0.205**; α** = 0.01**)** Share within the limits of variation scope, %									
A	28.0	0.4	16.4	9.0	7.8	4.3	1.0	11.7	1.3	31.6
H	13.1	1.4	18.0	10.7	18.2	0.7	10.6	19.7	1.7	11.3
II variant	**Correlation matrix** (**R** min = 0.15, **α** = 0.05), 169 cases, **O_3** ≥ 20 mcg/m^3									
A	-0.43	0.20	0.00	-0.07	0.22	-0.05	0.16	0.07	-0.34	-0.63
H	-0.11	0.12	-0.18	-0.13	0.21	-0.09	-0.06	-0.19	-0.06	-0.18
	For A, (R^2=0.617**; α** = 0.01**); For H, (R^2**=0.28**; α** = 0.01**)** Share within the limits of variation scope, %									
A	28.4	13.1	21.9	8.9	12.0	3.5	5.2	7.4	1.3	27.7
H	17.6	12.7	23.0	10.5	15.8	3.0	5.0	22.6	2.5	6.0

In table 5 there are presented data about linear correlation and multiple linear regression between daily values of some atmospheric parameters and 24 hours' quantity of calls of fast medical aid and the cases of hospitalization in Tbilisi [80]. In the upper part of the table (**I variant**) the calculations for all cases of observations are given, in the lower (**II variant**) - with the mean daily concentrations of ozone ≥ 20 mcg/m^3.

In particular, in the first variant the significant correlation between the pairs **Rn - A**, **N - A** and **N(+/-) - H** are observed; in the second variant - between the pairs **N - A** and **N(+/) - H**.

As follows from this table the contribution of variations in the concentration of light ions to the changeability of a quantity of cases of hospitalization is sufficiently essential (20 and 23 % for first and second variants) and commensurate with the contribution of such atmospheric parameters as the air temperature (13 and 18 %), atmospheric pressure (18 and 23 %), surface ozone concentration (18 and 16 %).

The influence of changeability of ion concentration on the quantity of calls fast medical aid is somewhat less (contribution 12 and 7%). The directly contribution of variations in the content in air of radon and secondary aerosols into the changeability of **A** and **H** is considerably lower than ions. Thus, in contaminate air variation of radon content influence on the physiological state of people indirectly, through the variability of the ion concentration.

Recently, work is continuing to study the effect of natural ionizing radiation on climate change and its individual components. For instance, the paper [85] considers the results of the study of the connection between annual variations of intensity of galactic cosmic rays and the changeability of cloudiness and air temperature in 1963-1990 in Tbilisi. The statistical characteristics of the indicated parameters (trends, random component, linear correlations between real and random components, etc.) are studied. In particular, we established that the correlation of the real values of cosmic ray intensity with the real values of total cloudiness is positive, with lower cloudiness – is not significance, with air temperature – is negative. The correlation of the random components of the intensity of cosmic ray intensity with the random components of lower and total cloudiness – are positive, with the air temperature - is negative. Within the variation range the contribution of the studied parameters to air temperature variability is as follows: real values of total cloudiness- 5.0%, random components of lower cloudiness – 1.0%, real values and random components of cosmic ray intensity - 3.0% and 4.1%, respectively.

Boleslovas Styra was in love with his work, was honest, fundamental, always highly valued its colleagues, was responsive and simple in the intercourse with them. His dear expression at the scientific discussions was "A that they will say my wise men? = А что скажут мои мудрецы?", "Let us listen to, that will say my wise men = Послушаем, что скажут мои мудрецы". He brought up a whole cohort of the scientists, with many of whom the author of this work, still being the graduate student of B. Styra, was favored the honor to have direct practical and friendly contacts. His followers possessed the same special attractive charm as B. Styra's itself. Unfortunately, many of them left this peace, bright by them memory. B. Styra was an exemplary family man, he loved guests and was hospitable proprietor, adored his wife Tatiana and son Dmitrijus. His salient qualities always served as an example for the author of this work, which he tries to adhere to this day.

References

[1] Blažienė I. Boleslovas Styra = Болеслав Стыро. Literatūros rodyklė. Vilnius, 1983, pp. 116-120.

[2] Butkus D. Profesorius B. Styra – branduolinės meteorologijos kūrėjas. Šiuolaikinė fizika Lietuvoje. Kaunas, 1997, pp. 354-363.

[3] Makariūnienė E. Lietuvos fizikų ir astronomų sąvadas. Vilnius, 2001, p. 33.

[4] Styra Boleslovas: (biografija). Lietuvos geografai: enciklopedinis žinynas, Vilnius, 2007, pp. 239-240.

[5] Špirkauskaitė N. Boleslovo Styros 95-osios gimimo metinės: (apie memorialinės lentos atidengimą Savanorių per. 231). Fizikų žinios, Nr. 33, 2007, p. 22.

[6] Makariūnienė E. Styra Boleslovas: (biografija). Visuotinė lietuvių enciklopedija, t. 22, Vilnius, 2012, p. 541.

[7] Pocius V. Prof. Boleslovas Styra: žymiausiam atmosferos tyrinėtojui Lietuvoje prof. Boleslovui Styrai – 100 metų. Mokslas ir gyvenimas, Nr.11/12, 2012, pp. 16-17.

[8] Styro B.I. Izuchenie radioaktivnosti atmosferi. Raboti litovskikh uchenikh. Vestnik AN SSSR, № 8, 1957 s. 49-54, (in Russian).

[9] Styro B.I. Voprosy yadernoy meteorologii. Izd. In-t geol. i geogr. AN litovskoy SSR, 1959, 418 s., (in Russian).

[10] Styro B.I. Yadernaya meteorologiya. L., Gidrometeoizdat, 1965, 140 s., (in Russian).

[11] Styro B.I. Samoochishcheniye atmosfery ot radioaktivnykh zagryazneniy. L., Gidrometeoizdat, 1968, 288 s., (in Russian).

[12] Styro B.I, Luyanas V.Yu, Shopauskas K.K. Radioaktivnost' atmosfery i meteorologiya. Vil'nyus, Mintis, 1975, 271 s., (in Russian).

[13] Styro B.I, Butkus D.B. Geophysical problems of krypton-85 in atmosphere. Vil'nyus, Mokslas, 1988, 158 p., (in Russian).

[14] Styro B.I., Nedvetskayte T.N., Filistovich V.I. Izotopy ioda i radiatsionnaya bezopasnost'. SPb., Gidrometeoizdat, 1992, 255 s., (in Russian).

[15] Styro B.I. Pervoye soveshianie po yadernoy meteorologii. The Soviet Journal of Atomic Energy. Volume 9, Issue 5, 1960, pp. 422–423, (in Russian).

[16] Styro B.I. Some problems in nuclear meteorology. The Soviet Journal of Atomic Energy. Volume 11, Issue 6, 1962, pp. 1185–1189, (in Russian).

[17] Styro B.I. Yadernaya meteorologiya – novyy razdel fiziki atmosfery. Tr. In-ta geofiziki AN GSSR, t. 28,"Metsniereba", Tbilisi, 1972, s. 108-112, (in Russian).

[18] Institute of Geophysics – 50. (Editor - Academician Balavadze B.K.). Metsniereba, Tbilisi, 1983,144 s. (in Russian).

[19] Chkhetia M.A., Chkhenkeli Sh.M. Radiometricheskoie issledovanie mineralnikh istochnikov Sairme. Otchet geofizicheskogo instituta Gruzfiliala AN SSSR, 1939, 5 s.
[20] Kebuladze V.V., Torozova L.I. Radioaktivnost Borjomskikh I Suramskikh mineralnikh vod. Trudi Instituta geofiziki AN GSSR, tom 13, izd. AN GSSR, Tbilisi, 1954, s. 131-135, (in Georgian).
[21] Chkhenkeli Sh.M., Torozova L.I. Radioaktivnost presnikh i mineralnikh vod Abkhazskoi ASSR. Trudi Instituta geofiziki AN GSSR, tom 15, izd. AN GSSR, Tbilisi, 1956, s. 95-101, (in Russian).
[22] Chkhenkeli Sh.M., Torozova L.I., Tsereteli Ts.I. Radioaktivnost presnikh i mineralnikh vod Svanetii I gornoi Megrelii. Trudi Instituta geofiziki AN GSSR, tom 16, izd. AN GSSR, Tbilisi, 1957, s. 91-96, (in Russian).
[23] Torozova L.I. K voprosu o genezise radioaktivnosti Tskaltubskikh mineralnikh istochnikov. Trudi Instituta geofiziki AN GSSR, tom 17, izd. AN GSSR, Tbilisi, 1958, s. 383-404, (in Russian).
[24] Styro B., Vebra E.I., Sopauskas K., Khundzhua T.G. Coagulation of the Solid Phase of Radioactive Aerosols with Cloud Droplets. Soobsh. Akad. Nauk Gruz. SSR, 33(1), 1964, (in Russian).
[25] Styro B.I., Verba E.Yu., Shopauskas K.K., Khundzhua T.G. Determination of Turbulent Diffusion Distribution Along the Vertical Concentration of Radon Decay Products in the Atmosphere. Soobsh. Akad. Nauk Gruz. SSR, vol. 43(2), 1966, (in Russian).
[26] Styro B.I., Chkhenkeli Sh.M., Tavartkiladze K.A., Khundzhua T.G. Vertical Distribution of the Natural Radioactivity in the Free Atmosphere at the Mean Cloud Level. Soobsh. Akad. Nauk Gruz. SSR, 49: 65-8, 1968, (in Russian).
[27] Styro B.I., Okroashvili G.G., Gamkhitashvili L.V., Khundzhua T.G. Concerning the Correlation of the Distribution of Radioactivity at Different Levels of the Atmosphere. Soobsh. Akad. Nauk Gruz. SSR 52: 635-8, 1968, (in Russian).
[28] Styro B.I., Chkhenkeli Sh.M., Tavartkiladze K.A., Khundzhua T.G. Regularities of the Distribution of Radon Decay Products According to the Atmosphere Altitude and the Magnitude of Vertical Turbulent Diffusion. Soobsh. Akad. Nauk Gruz. SSR, 54: 321-4, 1969, (in Russian).
[29] Styro B.I., Amiranashvili A.G., Okroashvili G.G., Khundzhua T.G. K teorii vertikal'nogo raspredeleniya yestestvennoy radioaktivnosti v prizemnom sloye atmosfery, Soobsh. AN GSSR,"Metsniereba", 71, N 2, 1973, s. 349-351, (in Russian).
[30] Styro B.I., Amiranashvili A.G., Khundzhua T.G Opredeleniye chislennykh parametrov, kharakterizuyushchikh vymyvaniye aerozoley blizhayshikh produktov raspada radona –222 v kuchevykh oblakakh, Tez. Dokl.Mezhd. konf. "Fizich. aspekty zagryazneniya atmosfery", Vil'nyus,18-20 iyunya 1974, s. 100, (in Russian).
[31] Styro B.I., Amiranashvili A.G., Khundzhua T.G K voprosu ob opredelenii postoyannoy vymyvaniya aerozoley korotkozhivushchikh produktov raspada radona-222 v konvektivnykh oblakakh, Tr. In-ta geofiziki AN GSSR, t. 36, "Metsniereba", 1975, s. 71-75, (in Russian).
[32] Styro B., Amiranashvili A., Gamkhitashvili L., Khundzhua T. On Vertical Non-Stationary Natural Radioactivity Distribution in Cumuli Clouds. Institute of Physics of the Academy of Sciences of the Lithunian SSR, Atmospheric Physics, ISSN 0135-1419, vol. 5, Vilnius, Mokslas, 1979, pp., 18-24, (in Russian).
[33] Styro B., Amiranashvili A. Some Results of the Investigation of Cumuli Clouds Natural Radioactivity. Institute of Physics of the Academy of Sciences of the Lithunian SSR, Atmospheric Physics, ISSN 0135-1419, vol. 5, Vilnius, Mokslas, 1979, pp. 25-41, (in Russian).
[34] Styro B., Amiranashvili A. Investigation of the Natural Radioactivity of Cumuli Clouds in the Process of Their Development and Disintegration. Institute of Physics of the Academy of Sciences of the Lithunian SSR, Atmospheric Physics, ISSN 0135-1419, vol. 5, Vilnius, Mokslas, 1979, pp. 42-50, (in Russian).
[35] Styro B.I., Kartsivadze A.I., Amiranashvili A.G., Khundzhua T.G., Tsitskishvili M.S. Issledovaniye protsessov zakhvata aerozol'nykh chastits v kuchevykh oblakakh, Tez. Dokl. Vsesoyuzn. Simp. po mikrofizike oblakov i osadkov, Tbilisi, 9-24 oktyabrya, 1979, s. 35, (in Russian).
[36] Styra B., Amiranashvili A. On the Cloud Drops Radioactivation. Institute of Physics of the Academy of Sciences of the Lithunian SSR, Atmospheric Physics, ISSN 0135-1419, vol. 7, Vilnius, Mokslas, 1981, pp. 25-28, (in Russian)
[37] Styra B., Amiranashvili A. Aerosol Distribution above Georgia Investigations. Institute of Physics of the Academy of Sciences of the Lithunian SSR, Atmospheric Physics, ISSN 0135-1419, vol. 8, Vilnius, Mokslas, 1983, pp. 18-24, (in Russian).
[38] Amiranashvili A.G., Gzirishvili T.G. Aerosols and ice crystals in the atmosphere. Tbilisi, Metsniereba, 1991, 113 p., (in Russian).

[39] Styra B., Golub T. Annual Course of Radon Decay Products in the Atmosphere Surface Layer. Institute of Physics of the Academy of Sciences of the Lithunian SSR, Atmospheric Physics, ISSN 0135-1419, vol. 7, Vilnius, Mokslas, 1981, pp. 53-55, (in Russian).
[40] Styra B., Golub T., Shpirkauskaite N. Atmospheric Circulation Types Influence on Short-Lived Radon Decay Products Distriburtion in the Surface Atmosphere. Institute of Physics of the Academy of Sciences of the Lithunian SSR, Atmospheric Physics, ISSN 0135-1419, vol. 8, Vilnius, Mokslas, 1983, pp. 36-40, (in Russian).
[41] Balabuyev A.G., Nodiya A.G., Amiranashvili A.G., Balavadze A.Sh., Tintilozov Z.K. Ionizatsionnoye sostoyaniye i yestestvennaya radioaktivnost' vozdukha v Novo-Afonskoy peshchere. Mater. Dokl. 2-go Resp. Seminara po nekotorym voprosam fiziki zemli, atmosfery, ionosfery i kosmicheskikh luchey, Tbilisi, 28-30 dekabrya 1977, s. 50-50, (in Russian).
[42] Amiranashvili A.G., Jishkariani J.M., Nodia A.G., Sepiashvili R.I., Tatashidze Z.K. Natural Air Radioactivity and Aeroions in Tskaltubo Cave. Academy of Science of Georgia, Tbilisi, 1994, 55 p., (in Russian), http://dspace.gela.org.ge/handle/123456789/537
[43] Amiranashvili A., Lominadze G., Melikadze G., Tsikarishvili K., Chikhladze V. Aero - Ionizing State and Radiological Situation in the Tskaltubo Cave. Trans. of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, vol. 60, Tbilisi, 2008, pp. 206 – 212 (in Russian).
[44] Tarkhan-Mouravi I., Saakashlili N., Tabidze M., Kakulia N., Kvinikadze I., Khelashvili E., Tarkhnishvili N., Amiranashvili A., Kirkitadze D., Tarkhnishvili A., Chikhladze V. Some Microclimatic Characteristic of Health Resort Tskaltubo. Trans. of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, vol. 60, Tbilisi, 2008, pp. 314 – 318, (in Russian).
[45] Amiranashvili A., Bliadze T., Nodia A., Nikiforov G., Chelidze L., Chikhladze V., Khazaradze K., Khazaradze R. Several researched results of radon concentrations in human environment, Proc. 1st Int. Conf. on Ecology and Environmental Management in Caucasus, Tbilisi, Georgia, October 6-7, 2001, pp. 61-62.
[46] Amiranashvili A., Bliadze T., Nikiforovi G., Nodia A., Chelidze L., Chikhladze V. Radonis shemtsveloba Tbilisis metropolitenshi. Hidrometeorologiis institutis shromebi, ISSN 1512–0902, tomi 108, Tbilisi, 2002, gv. 59–64, (in Georgian).
[47] Amiranashvili A., Bliadze T., Nodia A., Nikiforovi G., Chelidze L., Chikhladze V., Khazaradze R., Khazaradze K. Adamianis saarsebi sivrtseshi radonis kvlevis tsinastsari shedegebi. Q. Tbilisis ekologiuri problemebi. Q. Tbilisis meriis garemos datsvisa da bunebrivi resursebis regulirebis komiteti, Tbilisi, 2002, gv. 140–146, (in Georgian).
[48] Amiranashvili A., Chelidze T., Melikadze G., Trekov I., Todadze M. Quantification of the radon distribution in various geographical areas of West Georgia, Journal of the Georgian Geophysical Society, Issue A. Physics of Solid Earth, ISSN 1512-1127, vol. 12A, Tbilisi, 2008, pp. 65–69.
[49] Amiranashvili A., Chelidze L., Gvinianidze K., Melikadze G., Todadze M., Trekov I., Tsereteli D. Radon Distribution and Prevalence of Lung Cancer in Several Areas of West Georgia, Trans. of the Institute of Hydrometeorology, vol. No 115, ISSN 1512-0902, Tbilisi, 18 – 19 November, 2008, pp. 349–353.
[50] Amiranashvili A., Chelidze T., Melikadze G., Trekov I., Todadze M., Chankvetadze A., Chelidze L. Preliminary Results of the Analysis of Radon Content in the Soil and Water in Different Regions of West Georgia. Trans. of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, vol. 60, Tbilisi, 2008, pp. 213–218, (in Russian).
[51] Vaupotič J., Bezek M., Kapanadze N., Melikadze G., Makharadze T., Machaidze Z., Todadze M. Radon and Thoron Measurements in West Georgia. Journal of Georgian Geophysical Society, Issue (A), Physics of Solid Earth, v.15a, 2011-2012, pp. 128-137.
[52] Chen J., Kekelidze N., Jakhutashvili T., Kajaia G., Tulashvili E., Elizbarashvili M., Chkhaidze M. Georgian Individual Risks of Radon Induced Lung Cancer. Radiation Emergency Medicine, vol. 2, N 1, 2013, pp. 27-34.
[53] Tsitskishvili M.S., Tsitskishvili M.M., Chkhartishvili A.G. Problems of radioecology of Caucasus and education for sustainable future of region. "Radiological and agroecologycal Researches". Volume VI (The complete works consist of the materials of the International Conference devoted to XXX Anniversary of the Institute establishment), ISSN 1512-2786, Tbilisi, 2009, pp.28-34, (in Russian).
[54] Tsitskishvili M.S., Ninua T.L., Mikeladze M.O. Regional parameterization by atmospheric transfer for reduction radioactive pollution. "Radiological and agroecological Researches". Volume VI (The complete works consist of the materials of the International Conference devoted to XXX Anniversary of the Institute establishment), ISSN 1512-2786, Tbilisi, 2009, pp.181-185, (in Russian).
[55] Shengelaia G., Danelia K., Zardiashvili K., Khunjua A., Khunjua T. On Possible Precursor of the Tbilisi Earthquake on April 25, 2002, Bull. of the Georgian Acad. of Sci., 166, N 3, 2002, pp. 499-501.

[56] Amiranashvili A.G., Chikhladze V.A., Gambashidze R.A., Khunjua A.T., Nodia A.G. Preliminary Results of Investigations of Variations of Atmospheric Electric Parameter Peculiarities Over Tectonic Fractures and During Earthquakes, Proc. 12th Int. Conf. on Atmospheric Electricity, Versailles, France, 9-13 June, vol.1, 2003, pp. 403-406.
[57] Amiranashvili A., Matiashvili T., Nodia A., Khunjua A., Chikhladze V. Connection of Soil Radon and Air Electrical Conductivity with the Earthquakes. Trans. of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, vol. 60, Tbilisi, 2008, pp. 195–201, (in Russian).
[58] Melikadze G., Schubert M., Tsabaris Ch., Kapanadze N., Todadze M., Machaidze Z., Chankvetadze A. Using Environment Tracers for Investigation of Submarin Groundwater Discharge. Journal of Georgian Geophysical Society, Issue A. Physics of Solid Earth, vol. 16A 2013. http://dspace.gela.org.ge/handle/123456789/4823
[59] Melikadze G., Kapanadze N., Todadze M., Machaidze Z., Chankvetadze A., Tsabaris Ch., Androulakaki E., Pappa F., Eleftheriou G., Patiris D., Schubert M., Knoeller K., Stollberg R., Mallast U. Using Environment Tracers for Investigation of Black Sea Pollution. Complex Research of Earthquake's Forecasting Possibilities, Seismicity and Climate Change Correlations, BlackSeaHazNet Workshop, Sofia, Bulgaria; 12/2013 http://217.147.230.60/handle/123456789/4823
[60] Melikadze G., Todadze M., Kapanadze N., Körting O., Müller B., Vaupotič J., Andreeva P., Kiselinov Hr. Study Interaction between Seismicity and Gas Emission on the Territory of Georgia. Complex Research of Earthquake's Forecasting Possibilities, Seismicity and Climate Change Correlations, BlackSeaHazNet Workshop, Sofia,Bulgaria; 12/2013 http://217.147.230.60/handle/123456789/4821
[61] Kapanadze N., Bezek M., Vaupotič J., Melikadze G. Radon and Thoron Levels in Air at Selected Places in Georgia. Complex Research of Earthquake's Forecasting Possibilities, Seismicity and Climate Change Correlations, BlackSeaHazNet Workshop, Sofia, Bulgaria; 12/2013. http://dspace.gela.org.ge/handle/123456789/4822
[62] Melikadze G., Kralik M., Pavuza R. Hydrogeological and Speleometeorological Dynamics of the Prometheus and Sataplia Show-Caves, Imereti, Georgia. Journal of Georgian Geophysical Society, Issue (A), Physics of Solid Earth, vol. 17a, 2014, pp. 76-101. http://openjournals.gela.org.ge/index.php/GGS/article/view/1629
[63] Melikadze G., Jimsheladze T., Todadze M., Vepkhvadze S., Kapanadze N. Some Aspects of Natural Gases Distribution on the Territory of Georgia. Bulgarian Academy of Sciences, Engineering Geology and Hydrogeology, 28, Sofia,2014, pp. 15-24.
[64] Schubert M., Knöller K., Stollberg R., Mallast U., Ruzsa G., Melikadze G. Evidence for Submarine Groundwater Discharge into the Black Sea—Investigation of Two Dissimilar Geographical Settings, Water 2017, 9(7), 468.
[65] Rosinski J., Nadamoto C.T., Young J.A., Wogman N.A., Perkins R.W. Radionuclides as Ice-Forming Nuclei. J. de Rech. Atm, vol. 6, No 4, 1972, pp. 693-696.
[66] Muraleedharan T.S., Subba Ramu M.S., Vohra K.G. Experimental Studies of the Formation of Aitken Nuclei in the Atmosphere. Proc. 11th Int. Conf. on atmospheric aerosols, Condensation and Ice Nuclei, Budapest, Hungary, 3-8 September. Vol.1, pp. 52-57, 1984.
[67] Israelsson S., Schutte Th., Pisler E., Lundquist S. Effects of Radioactive Fallout on Lightning Frequency. Proc. of the 8th International Conference on Atmospheric Electricity, Uppsala, Sweden, 13-16 June, 1988, pp. 416-419.
[68] Amiranashvili A.G., Gzirishvili T.G., Chumburidze Z.A. On the role of artificial iceforming reagents and radioactive intermixtures in the variation of convective clouds thunderstorm and hail activity. Proc. 12th Int. Conf. on Clouds and Precipitation, Zurich, Switzerland, August 19-23, vol. 1, 1996, pp. 267-270.
[69] Amiranashvili A.G., Amiranashvili V.A, Beritashvili B.Sh., Mkurnalidze I.P., Chumburidze Z.A. Some Characteristics of a Thunderstorm Activity in Georgia. Proc. 12th Int. Conf. on Atmospheric Electricity, Versailles,France, 9-13 June , vol.1, 2003, pp. 711-714.
[70] Amiranashvili A.G., Amiranashvili V.A., Kirkitadze D.D., Chiabrishvili N.G., Chochishvili K.M. To a Question About the Formation of Secondary Aerosols in the Atmosphere. Trans. Of M. Nodia Institute of Geophysics of Georgian Acad. Of Sci., ISSN 1512-1135, vol. 58, 2004, pp. 119-126, (in Russian).
[71] Amiranashvili A. Scheme of the interaction of atmospheric aerosols and convective clouds, IUGG 2003 Abstract, Sapporo, Japan, June 30-July 11, 2003, MI02b/D-041.
[72] Amiranashvili A.G., Amiranashvili V.A., Gzirishvili T.G., Kharchilava J.F., Tavartkiladze K.A. Modern Climate Change in Georgia. Radiatively Active Small Atmospheric Admixtures. Monograph, Trans. Of M.Nodia Institute of Geophysics of Georgian Acad. Of Sci., ISSN 1512-1135, vol. LIX, 2005,128 p.

[73] Amiranashvili A.G. Issledovaniye grozo-gradovykh protsessov v Gruzii i ikh svyazey s aerozol'nym zagryazneniyem atmosfery. Avtoreferat dissertatsii na soiskaniye uchenoy stepeni doktora fiziko-matematicheskikh nauk, 04.00.23 – geofizika, fizika atmosfery i gidrosfery, Institut geofiziki im. M.Z. Nodia, Tbilisi, 2006, 53 s., http://www.dspace.gela.org.ge/bitstream/123456789/ 4920/1/Amiranashvili_ Avtoreferat_2006.pdf
[74] Amiranashvili A.G. On the Role of Cosmic and Radioactive Radiation on the Formation of the Secondary Aerosols in Atmosphere, Int. Conference "Near-Earth Astronomy 2007" Abstract, Terskol, Russia, 3-7 September 2007.
[75] Amiranashvili, A.G., Amiranashvili, V.A., Bakradze, T.S., Chikhladze, V.A., Glonti, N.Ya., Kharchilava, J.F.,Tuskia, I.I On the influence of cosmic rays on the secondary aerosols formation in the atmosphere. 7th Int. Conference "Problems of Geocosmos", Abstract, 26 – 30 May, 2008, St. Petersburg, Russia.
[76] Amiranashvili A., Bliadze T., Kirkitadze D., Nikiforov G., Nodia A., Chankvetadze A., Chikhladze V. Surface Radon as the Air Pollution Catalyst by Secondary Aerosols in Tbilisi. Trans. Of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, vol. 62, Tbilisi, 2010, pp. 197-206, (in Russian).
[77] Amiranashvili A. Negative Correlation Between of Light Ions Content and Radon Concentration: Particularity of Tbilisi City Air Pollution, or Norm for the Urbanized Locality? Proc. Of the 14th Int. Conf. on Atmospheric Electricity, Rio de Janeiro, Brazil, August 07-12, 2011, http://www.icae2011.net.br/.
[78] Amiranashvili A. Tbilisi Type of Smog as Attribute of Feedback Effect Between the Air Ionization Intensity and Small Ions Concentration, Proc. Of 7th Asia-Pacific Int. Conf. on Lightning, Chengdu, China, November 1-4, 2011, http://www.apl2011.net/.
[79] Amiranashvili A. The feedback effect of intensity of ionizing radiation with the light ions content in atmosphere. Paradox (the Tbilisi type of a smog), or usual phenomenon for the strongly pollution cities? Proc. Of Int. Conf. "Environment and Global Warming" Dedicated to the 100th Birthday Anniversary of Academician F. Davitaya, Collected Papers New Series, N 3(82), ISSN 2333-3347, Tbilisi, 2011, pp. 95-100.
[80] Amiranashvili A., Bliadze T., Chikhladze V. Photochemical smog in Tbilisi. Monograph, Trans. Of Mikheil Nodia institute of Geophysics, ISSN 1512-1135, vol. 63, Tb., 2012, 160 p., (in Georgian).
[81] Amiranashvili A. Some results of study of variations of light ions concentration and their connections with the ionizing radiation and sub-micron aerosol content in air under the conditions of Tbilisi city. Proc. Of 15th Int. Conf. on Atmospheric Electricity, Norman, Oklahoma, USA., 15-20 June 2014, http://icae2014.nwc.ou.edu/
[82] Amiranashvili A.G. Tbilisskiy tip smoga I yego osobennosti. Mezhdunarodnaya konferentsiya «Aerozol' I optika atmosfery» (k stoletiyu G.V. Rozenberga), Tezisy dokladov, 21-24 oktyabrya, Moskva, 2014, s. 67.
[83] Amiranashvili A.G. Increasing Public Awareness of Different Types of Geophysical Catastrophes, Possibilities of Their Initiation as a Result of Terrorist Activity, Methods of Protection and Fight With Their Negative Consequences. Engaging the Public to Fight Consequences of Terrorism and Disasters. NATO Science for Peace and Security Series E: Human and Societal Dynamics, vol. 120. IOS Press, Amsterdam•Berlin•Tokyo•Washington, DC, ISSN 1874-6276, 2015, pp.155-164. http://www.nato.int/science; http://www.springer.com; http://www.iospress.nl
[84] Amiranashvili A., Chargazia Kh. Intra-Annual and Seasonal Variations of Sub-Micron Aerosols Concentration and their Connection with Radon Content in Surface Boundary Layer of Tbilisi City. Bulletin of the Georgian National Academy of Sciences, vol. 10, N 2, 2016, p. 72-78.
[85] Amiranashvili A.G., Bakradze T.S., Ghlonti N.Ya., Khurodze T.V., Tuskia I.I. On the Connection between Annual Variations of the Intensity of Galactic Cosmic Rays and the Changeability of Cloudiness and Air Temperature in Tbilisi. Journal of the Georgian Geophysical Society, Issue B. Physics of Atmosphere, Ocean and Space Plasma, v.19B, 2016, pp. 128-134.

ბოლესლავ იოსების ძე სტირო. დაბადების 105 წლისთავისათვის. მისი როლი საქართველოს ბირთვული მეტეოროლოგიის ჩამოყალიბებაში, მის განვითარებასა და თანამედროვე ევოლუციაში

ა.ამირანაშვილი

რეზიუმე

ნაშრომი ეძღვნება გამოჩენილ ლიტველ მეცნიერს ბოლესლავ სტიროს, ატმოსფეროს ფიზიკის ახალი მიმართულების - ბირთვული მეტეოროლოგიის დამაარსებელს. აღნიშნულია მისი როლი საქართველოში ამ მიმართულების ჩამოყალიბებაში, მის განვითარებასა და თანამედროვე ევოლუციაში.

Болеслав Иосифович Стыро. К 105-летию со дня рождения. Его роль в становлении, развитии и современной эволюции ядерной метеорологии в Грузии

А.Г. Амиранашвили

Резюме

Работа посвящена памяти выдающегося литовского ученого Болеслава Стыро, основателя нового направления физики атмосферы - ядерной метеорологии. Отмечается его роль в становлении, развитии и современной эволюции этого направления науки в Грузии.