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COOPERATIVE INFLUENCE OF GEOCOSMICAL AGENTS ON HUMAN ORGANISM

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At present the relation between Solar activity (SA) and varied processes on the Earth is beyond question. Nevertheless, the question what do the geocosmical agents near Earth's surface substantively modulate the biosystem functional state, up to now is open. In our research we have found, that geomagnetic field (GMF) variations influence on varied functions of human organism [1-3], including the functional state of human brain [4], immune and cardio-vascular systems [5,6], peripheral blood [1,2,3,7]. In addition we have shown the bioeffectiveness of secondary cosmic rays (CR) near Earth's surface for blood cells and cellular cultures, growing in vitro [8-11]. The results of our investigations have made it possible to suppose that GMF and CR impact on biosystems by joint contributions [12] in "dose" exposure to geocosmical agents, associated with SA. The goal of this research is to demonstrate the cooperative influence of geocosmical agents on human organism functional state.

Materials and methods. In the course of this study, some morpho-functional characteristics of peripheral blood and indices of nonspecific immune-steadiness were assessed on daily basis through one month on the older schoolboys-volunteers [1,3,4]. Investigation was performed at high latitudes (66.3° N, 33.7° E), which are characterized by a minimum threshold of the geomagnetic cut of cosmic rays (the hardness of the magnetic cut is 1 GV, which corresponds to the particles with energy >430 MeV [13]) and, hence, by both an intensity higher than at middle latitudes and possible biological efficiency of secondary cosmic rays near the Earth's surface. The assessment of complete blood count: erythrocyte sedimentation reaction (ESR), hemoglobin level (Hem), the total leucocytes quantity (Leu), eozinophils (Eoz), segmented neutrophils (Segm), stab neutrophils (Stab), limphocytes (Lph), plasmacytes (Plc), monocytes (Mon), phagocytosis (Phag), metabolically stimulated granulocytes (NBT) by zimozane and nitroblue tetrazoly as also indices of the reaction of vesicular-formed (RVF) [11,14] were included in morpho-functional characteristics of peripheral blood. The growth of nonpathogenic (Auto microflora), pathogenic and conditionally pathogenic (Pat. Micro flora (M+)) microflora in human organism were assessed on bronchial asthma patients (BA) and healthy volunteers. Besides, bactericidal activity [15] of skin cover of healthy volunteers was also tested. Hence the functional state of human organism has been characterized by indices list presented in Tables 1,2.

Indices of global geocosmical agents, associated with SA were included: number of sunspots (R); X-rays 1-8A°; velocity (V) of solar wind; the density of particles (N) in solar wind and solar protons with energy > 100 Mev; the sector structure signs and strength of interplanetary magnetic field (IMF); index of planetary geomagnetic activity (Kp). The data on the fluxes of nuclear-active particles in the near Earth space, which could generate the secondary cosmic radiation near the Earth's surface at the latitude of investigation, were obtained from the GOES-6 satellite: α – particles with energy range 630-850 MeV and >850 MeV. Regional and local variations of geocosmical agents were presented by the data of uncorrected (uncor) and corrected (CR) rates of neutron counts on atmospheric pressure, atmospheric pressure obtained from the observatory of the Polar Geophysical Institute, Kola Research Center, Russian Academy of Sciences, Apatity (67.57° N, 33.4° E). The neutron component is detected by ground-based neutron monitors and it usually is corrected for the atmospheric pressure to study the temporal variations of the flux of the primary cosmic rays (CR) in the near-Earth space under review latitude. However, the data on the neutron count uncorrected for atmospheric pressure should be used to estimate the biological efficiency of the neutron component because they reflect the intensity of the nucleon component near the Earth's surface. Therefore, the assessment of the biological efficiency of the neutron component was performed on the basis of the corrected and uncorrected neutron count.

We also used the data on local variations of the H-component of the total GMF [1,3,4]: the maximal values of the daily rH-index (rHmax-index) and the difference between the maximal and the minimal values of H-component (delta H-index) during 24-hour interval; the indices of short-periodic oscillations (SPO) of the H-component, T=1s - 200s (SPO2) with amplitude (A) of oscillation 3nT< A <

10 nT and SPO3, where 10 nT < A < 20 nT [1,3,4]. The relation between indices of human organism functional state and variations of the geocosmical agents has been analyzed by the Technology of System Reconstruction (TSR) [16] along with common statistical methods.

Results and discussion. We have studied the correlation between temporal series of indices of geocosmical agent variations and the data of peripheral blood functional state are averaged over every day for ensemble of examinees (Table 1). The signs and values of correlation coefficients show the many-valued relations between geocosmical agent variations and the separate indices of peripheral blood functional state. From this it follows, that separate components of peripheral blood (or targets) have selected heightened sensibility to effects of the certain geocosmical agents. As this takes place, segmented neutrophiles (Segm), lymphocytes (Lph), phagocytes (Phag) and the reaction of vesicular-formed (RVF) have the most number of correlations with global and local geocosmical agents.

Table 1. Correlation coefficients between the values of geocosmical agent variations and the data of peripheral blood functional state are averaged over every day for ensemble of examinees**.**

Geocosmical agents	*ESR*	*Hem*	*Leu*	*Eoz*	*Segm*	*Stab*	*Lph*	*Plc*	*Mon*	*Phag*	*NBT*	*RVF*
Sunspot number (R)	0,056	0,372	0,177	-0,15	-0,31	0,036	**0,563**	0,067	**-0,46**	-0,394	0,162	-0,352
X-rays 1-8A°	0,303	0,277	-0,06	-0,31	0,086	0,128	0,247	-0,05	**-0,53**	-0,22	**0,53**	-0,487
Velocity solar wind, *km/c*$^{-1}$	0,114	0,437	0,109	-0,33	**-0,472**	0,34	**0,806**	0,177	**-0,5**	-0,21	-0,07	**-0,614**
Particle density (N), *n/cm*$^{-3}$	0,25	**-0,63**	-0,2	0,228	**0,47**	-0,34	**-0,7**	-0,16	0,396	0,246	0,324	0,207
Solar protons >100 *MeV*	-0,02	0,019	0,303	-0,06	-0,15	-0,03	0,241	-0,08	-0,14	**-0,718**	0,079	-0,248
α-particles, 630-850 *MeV*	-0,06	-0,22	0,103	-0,18	-0,01	-0,28	-0,03	-0,06	0,308	0,406	-0,11	**0,553**
α-particles >850 *MeV*	-0,11	0,121	0,079	-0,18	0,199	-0,24	0,018	-0,07	-0,13	0,24	-0,2	0,501
IMF, *nT*	-0,01	0,477	0,252	0,073	-0,23	0,316	0,186	0,127	-0,15	**-0,504**	0,127	-0,124
Total vector IMF	0,324	0,242	0,057	0,149	-0,12	0,146	0,028	0,362	0,071	0,346	-0,2	**0,577**
Sector structure IMF	0,167	**-0,55**	-0,45	-0,02	**0,571**	0,017	**-0,63**	0,01	0,272	0,068	0,296	0,081
rH-index, *nT*	0,227	0,325	0,012	-0,15	-0,06	0,338	0,255	0,267	-0,38	-0,386	0,358	-0,483
rHmax-index, *nT*	0,172	0,376	-0,07	-0,25	-0,06	**0,483**	0,236	**0,502**	-0,27	-0,421	0,339	-0,47
deltaH-index, *nT*	0,295	0,3	0,007	-0,12	-0,1	**0,465**	0,224	0,366	-0,3	**-0,462**	**0,445**	**-0,534**
SPO2	0,084	**0,447**	0,061	-0,13	-0,28	**0,743**	0,335	**0,46**	-0,18	-0,3	0,081	**-0,577**
SPO3	0,297	0,245	-0,14	-0,2	-0,02	0,258	0,314	0,133	-0,51	-0,313	0,259	**-0,567**
Barometric pressure	0,279	0,13	0,211	-0,03	**-0,47**	0,18	**0,487**	0,162	-0,15	-0,388	0,217	0,176
cor. neutron count rate	-0,17	-0,16	-0,11	0,095	0,141	-0,12	-0,35	-0,03	0,382	**0,522**	-0,195	0,505
uncor neutron count rate	-0,29	-0,31	-0,3	0,152	**0,438**	-0,12	**-0,64**	-0,14	0,365	0,403	-0,14	0,479

Note: Significant correlation coefficients ($p < 0.05$) are boldfaced.

On the whole, the all correlations of the geocosmical agents with indices of the blood functional state can be divided off two groups: with positive signs of correlations concerning of geomagnetic activity and with negative signs with one. Moreover, if the indices of blood functional state have negative signs of correlation with indices of geomagnetic activity, that the signs of correlation with corpuscular component of geocosmical agents of such indices will be positive. In such a way, Segm and Mon, Phag, RVF have significant negative correlation coefficients with global and local geocosmical indices, associated with the increase of SA (R, V, X-rays, solar protons, IMF, delta H-index, SPO2, SPO3) and positive signs of correlations with indices, associated with increase of neutron intensity near Earth's surface. On the contrary, Lph, NBT have positive signs of correlation with geoeffective agents, associated with the increase of SA and negative signs of correlation with neutron intensity near Earth's surface. Inasmuch as Segm, Phag, Lph, Mon compose cooperative integral system controlling immune responses and other blood functions and the distinct elements of this system have the opposite signs correlation with geomagnetic activity and secondary component of CR near Earth's surface, one can be suggested that modulation of the biosystem functional state are realized by the cooperative influence of GMF variations and CR.

For better visualization of this ideas, we have normalized the each value of temporal series of indices, associated with SA, relatively their maximum: 1) global indicators of the local events realizing on the Earth's surface (velocity (V) of solar wind; the density of particles (N) in solar wind and Kp-index of planetary geomagnetic activity); 2) the main global geocosmical agents near Earth space modulating the local events on the Earth's surface (the sector structure of interplanetary magnetic field (IMF), the fluxes of cosmic rays in near Earth's space under review latitude, estimated by neutron count rate corrected on atmospheric pressure (CR)); 3) local geocosmical agents near the Earth's surface are presented by indices of local geomagnetic activity (rHmax, delta H) and neutron count rate uncorrected

on atmospheric pressure (uncor) (see Table 2). Then, we have picked out the dates with the maximum and minimum values of organism functional state indices (from ensemble-averaged sampling effects over every date) and have confronted with normalized values of geocosmical indices corresponding these dates (Table 2). Finally, we find the possibility to estimate cooperative influence of geocosmical agents on organism functional state by the comparison of the "dose" ratio of the active agents.

Table 2. Confronting dates of manifestation of the maximum and minimum values of organism functional state indices with corresponding their normalized values of geocosmical indices

Indices of functional state	Maximum(+) and minimum (-) values	Local agents near Earth's surface			Global modulating agents		Global indicators of local events		
		rHmax	delta H	uncor	CR	IMF	Kp-index	N	V
ERS	+	0,5	0,6	0,7	0,9	0,9	0,3	0,7	0,4
	-	0,04	0,03	1	0,8	0,7	0,4	0,6	0, 6
Hemoglobin	+	0,9	0,8	0,6	0,4		0,7	0,1	0, 8
	-	0,04	0,03	1	0,8	0,7	0,4	0,6	0, 6
Leucocytes	+	0,2	0,2	0,5	0,8	-0,6	0,6	0,6	0, 6
	-	0,9	0,7	0,5	0,9	0,1	0,6	0,3	0, 7
Eosinophils	+	0,2	0,2	0,5	0,8	-0,6	0,6	0,6	0, 6
	-	0,6	0,5	0,5	0,9	0,6	0,6	--	-
Segments	+	0,01	0,02	0,8	0,9	0,4	0,4	0,8	0,4
	-	0,2	0,2	0,5	0,8	-0,6	0,6	0,6	0, 6
Stab neutrophils	+	0,9	0,7	0,5	0,9	0,1	0,6	0,3	0, 7
	-	0,2	0,1	0,7	1	-0,6	0,6	0,3	0, 6
Lymphocytes	+	0,1	0,1	0,4	0,8	0	0,5	0,1	0, 9
	-	0,2	0,1	0,6	0,9	1	0,3	1	0, 4
Plasmacytes	+	0,9	0,7	0,5	0,9	0,1	0,6	0,3	0, 7
Monocytes	+	0,04	0,03	1	0,8	0,7	0,4	0,6	0, 6
	-	0,5	0,5	0,3	0,2	--	0,8	0,4	1
Phagocytes	+	0,2	0,2	0,5	0,8	-0,6	0,6	0,6	0, 6
	-	0,6	0,6	0,1	0,3	-0,8	0,9	0,1	0, 8
NBT	+	0,2	0,2	0,5	0,9	--	0,6	--	-
	-	0,2	0,2	0,5	0,8	-0,6	0,6	0,6	0, 6
RVF	+	0,2	0,1	0,7	1	-0,6	0,6	0,3	0, 6
	-	0,5	0,5	0,3	0,2	--	0,8	0,4	1
Auto microflora	+	0,04	0,03	1	0,8	0,7	0,4	0,6	0, 6
	-	0,1	0,1	0,4	0,8	-0,05	0,6	--	-
Pat. Micro flora (M+)	+	0,04	0,03	1	0,8	0,7	0,4	0,6	0, 6
	-	1	1	0	0,1	-0,8	1	0,2	1
Bactericidal activity	+	0,2	0,1	0,7	1	-0,6	0,6	0,3	0, 6
	-	0,6	0,6	0,4	0,9	-0,5	0,9	0,2	0, 8

By such comparison, we have revealed the following possible mechanisms for modulation of organism functional state: 1) Alterative regulation by GMF variations and neutron intensity near the Earth's surface, when the one in a two component has maximum value and other – minimum value. For instance, conditionally pathogenic microflora (Pat. Micro flora (M+)) manifests the maximum growth under maximum neutron intensity and minimum geomagnetic activity and vice versa, when the geomagnetic activity has maximum value and neutron intensity is minimum, the growth of conditionally pathogenic microflora is minimum. By alterative mechanism are also regulated the minimum values of ERS, Hem indices and the maximum values of Mon, Auto microflora growth, when indices of geomagnetic activity are minimum and neutron intensity is maximum. 2) Complementary (additional) regulation, when the values of the GMF variations and neutron intensity near the Earth's surface reciprocally supplement each other. For instance, maximum values of ERS, Hem, Stab neutrophils, Plasmacytes and minimum value of Eosinophils. 3) Prevalent regulation by GMF variations or neutron intensity near the Earth's surface, when the one in a two component has predominant significance over other. So, for instance, when the neutron intensity near the Earth's surface prevails over geomagnetic activity, the Phag, Leu, RVF indices have maximum values. On the contrary, when the geomagnetic activity prevails, Phag, Mon, RVF indices have minimum values.

By this means, the human organism functional state are modulated by "dose" ratio of active agents, where basic role belongs to the GMF variations and the secondary component of CR, which are detected on the Earth's surface by neutron monitors. The net result of exposure of these agents on biosystems are determined by the sensitiveness of different organism systems to predominant impact of electromagnetic or

nucleon components near the Earth's surface. Relative contribution of each agents in common process of the biosystem functional state modulation are determined by "dose" ratio of GMA, intensity of nucleon component, organism functional activity. IMF, as global agent, modulates the GMF variations and intensity of secondary nucleon component of CR on the Earth's surface, and hence, it modulates the bioeffectiveness of the GMF variations and the secondary CR in the each span. SA and associated geocosmical agents (N, V, X-rays and etc.) are indicators of events, which will realized on the Earth's surface and which will directly impact on biosystems, by cooperative influence of GMF variations and CR.

Special investigations carried out to study the relation between the growth of nonpathogenic (Auto microflora), pathogenic and conditionally pathogenic microflora and variations of geocosmical agents. It was shown, that the growth of conditionally pathogenic and pathogenic microflora are relatively free from host immune system [17,18]. The relation between the growth of conditionally pathogenic microflora and geocosmical agent variations are demonstrated in Figure 1.

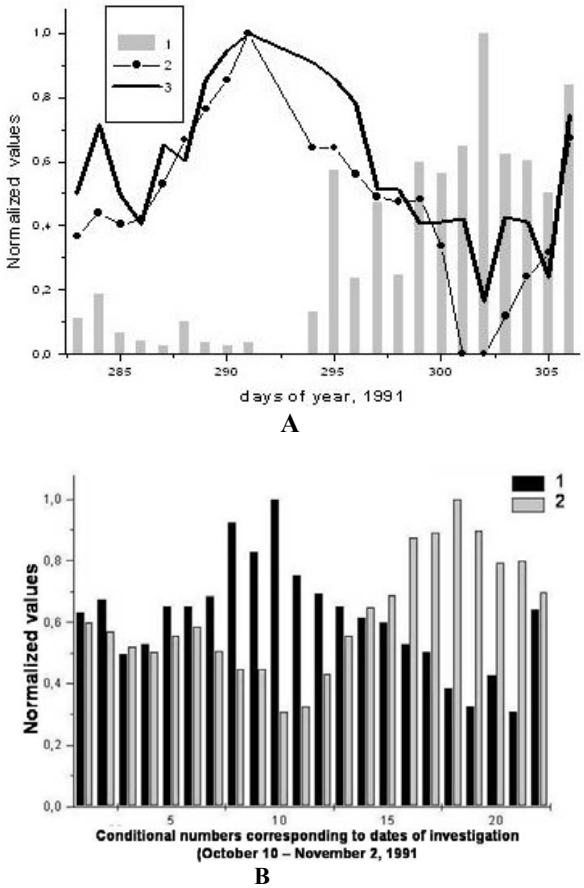

Figure 1. Correlation between the growth of conditionally pathogenic microflora (A-3; B-1), geomagnetic activity (A-1), neutron count rate (A-2) and solar activity (B-2).

Positive correlations were found between growth of conditionally pathogenic microbes on skin cover and variations of CR (α-particles with energy 630-850 MeV), r = 0,431 ($p<0,05$); IMF, r = 0,77 ($p<0,05$); neutron count rate near Earth's surface, r = 0,835 ($p<0,05$), Fig 1A. Correlation with SA (sunspots) and geomagnetic activity (delta H-index) had negative signs: r = - 0,773 ($p<0,05$) and r = - 0,53 ($p<0,05$), correspondingly (Fig 1A, B).

We have shown that the variations of CR and the solar wind plasma density have principal significance for modulation of pathogenic microbial growth in human organism, including parasitic fungi [18]. The data obtained under analysis of microbial growth inside of BA patient were similar with one concerning the microflora growth on skin cover of healthy volunteers. Our results demonstrate that the pathogenic microbial growth is controlled by alterative mechanism according to "dose" ratio of GMF variations and CR. The magnitude of microbial population abruptly increase, when the intensity of CR has maximum value and GMF variations – minimum one. In Solar cyclic activity such events are regularly observed in minimum of SA. Hence, that is the reason that influenza outbreaks and increase of diverse epidemics must be manifested in minimum of SA. In such a manner the biosystem functional state are modulated by cooperative influence of the GMF variations and CR, and in its turn are modulated by global geocosmical agents associated with SA .

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