
COMPARATIVE ANALYSIS OF MODERN RESEARCH METHODS BIOTROPIC EFFECTS OF SPACE WEATHER

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The possible mechanisms of the space weather influence on biological systems are discussed. Nonlinear processes of space weather influence to bio-systems are described.

Based on recent theoretical models of the dynamics of the old Sun discusses cosmogeophysical influence factors on the adaptation processes and the formation of life on Earth.

Key words: biotrophic influence of space weather; bio-system's adaptation process, nonlinear Dynamics; evolution of ancient eco-systems.

Background. For biologists and medical specialists biotrophic impact of space weather is a fact, synchronization of the heliosphere and the biosphere is confirmed by numerous experimental studies. However researchers are arguing about the mechanisms of this effect. The main stumbling block is the “undiscriminability” biotrophic single physical agent of influence, as well as the extremely low intensity of all of space weather factors.

Objectivities: development of new approaches for the creation of an adequate theoretical model biotrophic influence of space weather.

Materials and Methods. Comparative analysis of own and literature data to create a more adequate model biotrophic influence of space weather.

Results of Research. To solve this problem we have analyzed both published data and the results of their own research.

The classical model biotrophic influence space weather based on “heliocentric” and “linearity” basic scientific paradigm. It is supposed that after the solar flares that cause a range of changes in all spheres of the Earth, some of cosmogeophysical factors (most likely — variations, pulsation and more. Geomagnetic field, etc.) reach the biological object. And triggers switch the mode of operation, from the normal level to stress (at all levels of organization, from the cellular to the system and population). Linear response of the system is well recorded in the population spatial scales and temporal scales of months or more, or at the cellular level.

Details of this model considered V. Obridko in Chapter 8 of [4], which also noted that there is a significant difference between the accumulated experimental data and existing theoretical models.

In the last 100 years, the influence of factors cosmogeophysical reliably and reproducibly recorded numerous scientists at all levels of the organization of the biosphere. Since the work of A. Chizhevsky [12], researchers are finding more evidence sudden changes of physiological parameters that occur in the vicinity of magnetic storms, and directly affect on the behavior and health of the population [3].

Exogenous variation is the simple fact in almost all medical and biological monitoring, and often — as a side effect, which interferes the main study. Halberg et al found chronobiological emergence failures biosystems with sharp variations of factors of space weather. L.I. Dorman in 1972 drew attention to the meteorological and biological aspects of the effects of cosmic rays. Y.I. Gurfinkel [5] in the near-storms days showed an increase in blood clotting and more severe course of heart attacks, increase in the number of deaths critically ill patients, N.K. Belisheva et al. [1] in their study showed that the geomagnetic disturbances essentially simulate the growth and differentiation of cell structures. Under conditions of high geomagnetic activity they observed a decrease in DNA synthesis with compensation in the subsequent cell cycle.

In the works of D.N. Chichkan, A.V. Besedina and A.V. Kovaleva [13], a sharp increase in the number of white blood cells by neutrophils per day storms and their sharp decline in 2—3 days after the storm. The opposite sign of leukocyte changes compared against the change of the lymphocytic level to observe. S.M. Chibisov [4, Chapter 11] showed the presence of changes in the spectra of the acid-base status and functional activity of the cardiovascular system as a whole magneto-disturbing force day, and in his work shows the influence of changes in solar activity on the ultrastructure of cardiomyocytes. In independent studies, T.K. Breus (Moscow) [2] and S. Samsonov (Yakutsk) [4, Chapter 6] noted the coincidence of the spectra of the dynamics of emergency calls and the geomagnetic K index. The same effects are observed for healthy subjects. So in the works of E. Diatropova [16] observed the effect of failure, 4-day cycles of testosterone and cortisol in healthy volunteers during geomagnetic disturbances.

P.E. Grigoriev [4, Chapter 5] revealed modulation working capacity and mood. M.V. Ragulskaya, O.V. Habarov [8] — activation of adaptive creativity and adaptation of healthy people. In the works of N.I. Horseva [11] revealed a pronounced effect cosmogeophysical factors on fetal development and the probability of hereditary disorders. A more detailed review of the literature on this subject is given in section 2 (P.G. Petrova et al.) And 4 (S.M. Rogachev et al.) of the collective monograph “Biotropic influence of space weather” [4].

This is classic method for studying the influence of space weather biotropic applicable when considering the large spatial scales at the level of the entire population, or large scales time — at the level of months and years.

In real data on the average space-time scales observed no reproducible effect [12].

Their experimental studies, the authors have is shown that in the process of adaptation in the middle range of the characteristic times and sizes of biological systems behave as essentially non-linear dynamic systems open. With the inherent properties of

these systems, the response threshold and saturation effects, the bifurcation shift orderly and quasi-stochastic control, presence of amplitude-frequency response of windows and processes with total restructuring of the signal and the impact of external noise. The human heart is considering us a point source of oscillations to determine the direction of the dynamic development. V.V. Pipin et al. [7] constructed the distribution of the velocity field near the singular points of the heart.

The scenarios biotrophic effects of space weather are not possible without the answers to the question of the formation and evolution of adaptive functioning ancient scenario biosystems. When assessing the impact of early radiation of the sun and other cosmophysical factors on the formation of life on Earth and ancient evolutionary adaptation Biosystems decided to stick “principle of actualism” (the desire to build on the historical reconstructions of modern analogues). In the theoretical model originally laid conditions on the ancient Earth, much different from today's, and the terms of solar flux and default are considered similar to those observed in the present.

The differential rotation of the Sun identified closer to the stars with a less regular activity (typical for younger stars) than the stars with established cycles [6]. The young Sun observed more active non-stationary processes than previously thought. Applied to biophysical problems, this means that even in repose Sun epoch of formation of life on Earth in the vacuum ultraviolet (shorter than 304 Å) emit an order of magnitude larger than the current maximum of the Sun in the solar activity. Were substantially greater number sub sun-ray flare and their intensity, and the flow of soft X-rays. These pulse phenomena were accompanied by very efficient particle acceleration up to relativistic energies.

Another aspect biotrophic effects of space weather is in the influence of the galactic environment on development of terrestrial life. Here we must note two things:

1. Change intensity of galactic rays in the near-Earth space during the passage of the solar system galactic arms. The solar system is located on the periphery of our Galaxy, enough gas is discharged, and rotates around its center. In the main arms of the galaxy density of matter and electromagnetic fields is much larger. Therefore the periodic passage of the solar system through the galactic arms tenfold increase in the density of the interstellar gas in the edge of the solar system causes constriction of the heliosphere by a quarter. In this case, an increase in the intensity of cosmic rays on the Earth's orbit to 6 times [18]. If we consider that in the arms of the galaxy density of the interstellar gas is of this order of magnitude, the periodicity of extinctions of living organisms on Earth ~62 million years [19] may well be due to increased cosmic ray bombardment of the Earth due to the effect described above. Research in this area is carried out in the laboratory of Professor Melott (Kansas, USA) (see discussion in articles on <http://kusmos.phsx.ku.edu/~melott/Astrobiology.htm>).

2. Periodic supernova explosions that have a significant impact on the biosphere. Svensmark (2012) estimated the frequency of supernova explosions (Fig. 1) and compared it with periods of extinction of marine life at the time. All major peaks coincide with each other.

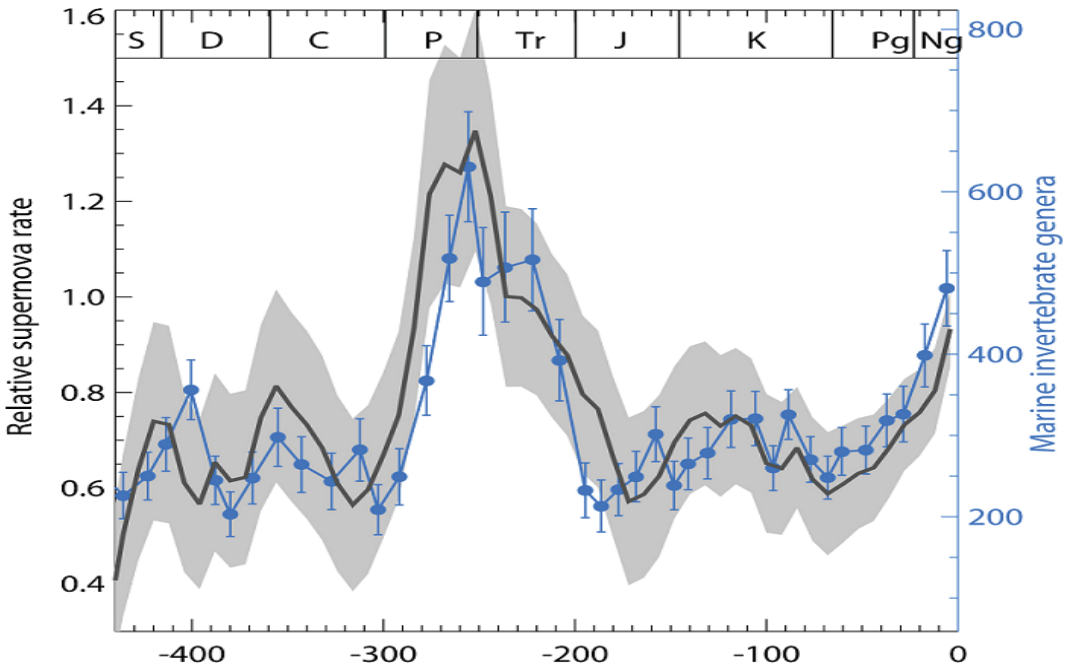


Fig. 1. Geological time in millions of years

Fig. 1 [17] solid black curve shows the author estimated the relative frequency of supernova explosions in the solar system crossed arms of the Galaxy. Curve with dots shows the number of births of marine invertebrates in the sediments with less influence of variations in sea level on the mortality of living organisms.

Conclusion. New data on the activity of the old Sun, and allow us to make a hypothesis about the origin of system cosmogeophysical evolutionary function.

Thus, the construction of evolutionary hypotheses “from solar physics to biology”, i.e. consideration of evolutionary processes with the new data on the activity of the early sun, increases by several orders of magnitude the intensity of external radiation in the period of formation of ancient ecosystems. This allows for a theoretical modeling of the adaptation of modern complex biosystems (from cells to society) by the modern concepts. These active experiments will give a more accurate assessment of the activity of the old Sun and of the formation of the solar-terrestrial relationships on early Earth.

As possible future directions for research biotropic effects of space weather can offer a comprehensive study of the nonlinear impact of space weather and normal activity and the dynamics of the old Sun and the conditions of space-time scale of the formation of life on Earth with the adaptive processes in terms of the probability of finding the system in a simultaneous set of possible states biotropic parameters to recreate the ancient activity of the Sun.

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ СОВРЕМЕННЫХ МЕТОДОВ ИССЛЕДОВАНИЙ БИОТРОПНОГО ВЛИЯНИЯ КОСМИЧЕСКОЙ ПОГОДЫ

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Работа посвящена рассмотрению возможных механизмов биотропного влияния космической погоды. Показано, что основной сценарий, разрабатываемый в настоящее время в научной литературе, является квазилинейным и требует существенной корректировки. Линейный отклик системы хорошо регистрируется на пространственных масштабах популяции и временных масштабах от месяца и более или на клеточном уровне.

При наличии больших объемов баз данных артефакты, в обычных экспериментах считавшиеся ошибкой измерений и априори выбрасываемые из рассмотрения, при повторной регистрации оказываются воспроизводимым результатом следующего уровня понимания исследуемых взаимосвязей.

На основе последних теоретических моделей динамики древнего Солнца обсуждаются вопросы влияния космогеофизических факторов на процессы возникновения и формирования жизни на Земле.

Ключевые слова: биотропное воздействие космической погоды, адаптация живых систем, нелинейная динамика, эволюция древних экосистем.