

SPACE WEATHER AND THE STATE OF CARDIOVASCULAR SYSTEM OF A HEALTHY HUMAN BEING

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ABSTRACT. The term “space weather” characterizes a state of the near-Earth environmental space. An organism of human being represents an open system so the change of conditions in the environment including the near-Earth environmental space influences the health state of a human being.

In recent years many works devoted to the effect of space weather on the life on the Earth, and the degree of such effect has been represented from a zero-order up to apocalypse. To reveal a real effect of space weather on the health of human being the international Russian-Ukrainian experiment "Geliomed" is carried out since 2005 (<http://geliomed.immsp.kiev.ua>) [Vishnevsky et al., 2009]. The analysis of observational set of data has allowed to show a synchronism and globality of such effect (simultaneous manifestation of space weather parameters in a state of cardiovascular system of volunteer groups removed from each other at a distance over 6000 km). The response of volunteer' cardiovascular system to the changes of space weather parameters were observed even at insignificant values of the Earth's geomagnetic field. But even at very considerable disturbances of space weather parameters a human being healthy did not feel painful symptoms though measurements of objective physiological indices showed their changes.

Key words: space weather, the Sun, cardiovascular system of a human being.

1. Introduction

At the end of 20th century after the beginning of flights of space vehicles measuring parameters of fluxes of particles, electromagnetic fields and radiations, there appeared understanding of that fact what represents the near-Earth environmental space and how fields, particles and radiations can reach this or that area of the near-Earth environmental space and make a possible impact on the Earth's life. And at the beginning of our century there

appeared a term “space weather” characterizing a state of the near-Earth environmental space. The main effect on a state of the near-Earth environmental space exerts the Sun. So a detection of mechanisms of connection between the Sun's activity and functioning of various objects of the biosphere including a human being is one of fundamental problems of the up-to-date science.

The organism of a human being represents an open system so a change of environmental conditions has an effect on a state of a human being's health. A cardiovascular system (CVS) is one of the first one which joins in the process of adaptation to the varying external conditions. Besides the obviously influencing factors of environment, such as meteorological parameters, and also social factors it has been revealed that electrical and magnetic fields, electromagnetic radiations which are not registered by feelings of a human being can influence the state of health. So the purpose of this work is to study the effect of space weather parameters on a state of a human being's CVS.

2. Experimental data and registration methods

The experiment was carried out simultaneously at 3 points of observation: Yakutsk (Russia), Kiev (Ukraine) and Simferopol (Ukraine) on the same equipment (Fazagraf sensor) by a common protocol of examination on a group of volunteers invited at each point of observation in November-December, 2008. As an index of functional state of a human being's CVS a T-wave symmetry which is the index of electrocardiogram (ECG) has been used. In more detail about an applicability of T-wave symmetry for estimation of CVS state of a human being and about operation of Fazagraph complex, one can see in [Fainzilberg, 1998 or Vishnevsky et al., 2003]. Thus, for each patient the individual set of data has been obtained for the whole period of experiment. Then, to create a continuous number of data an indices of each volunteer has been interpolated because measurements

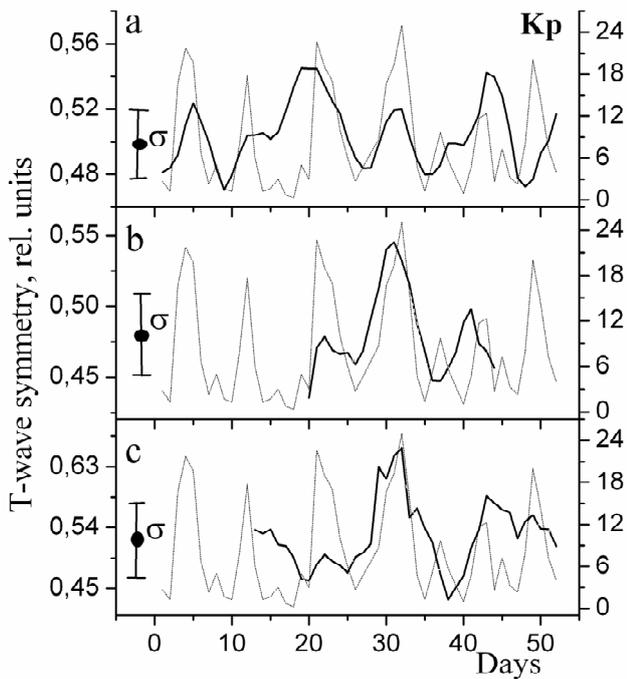


Figure 1: Temporal variations of the ECG T-wave symmetry coefficient (solid line) and geomagnetic disturbance Kp-index(dashed line) in : a) Yakutsk, b) Kiev, c) Simferopol.

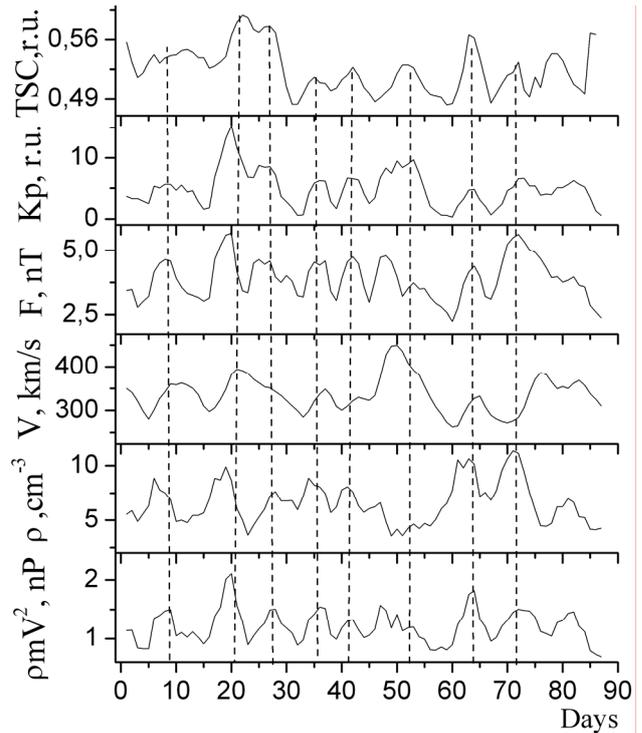


Figure 2: Changes of the CVS state of volunteer's group in Yakutsk and space weather parameters (October 5-December 30, 2009)

of the basic part of volunteer group were made only during the working days. For the purpose of smoothing of the T-wave symmetry coefficient (TSC) variations the data with a period less than 4 days have been filtered out.

The comparison of temporal TSC variations of each volunteer with temporal variations of the geomagnetic disturbance index has shown a coincidence of these indices of a part of volunteers. It is shown that 46,5 % of volunteers have had the temporary changes of TSC coinciding with changes of geomagnetic disturbance index. The mean age of volunteers with coinciding changes accounts for 46,9 years while the average age of volunteers with not completely coinciding changes accounts for 53,6 years. In the coinciding group it has been turned out to be 47,1 % of women and 46,2 % of men.

Contrastingly, in Kiev and Simferopol all volunteers have shown a coincidence of TSC variations with the changes of geomagnetic disturbance level both in the state of immobility and after emotional and physical loadings.

In Fig. 1 on the ordinate the averaged index of T-wave symmetry of volunteers' ECG in relative units (solid line) and the index of geomagnetic disturbance (dashed line) are shown, and on the abscissa the time in days (24 hours) from the beginning of experiment are given. The data of Yakutsk, Kiev and Simferopol are shown from top to down σ is a mean quadratic deviation. From Fig. 1 it is seen that virtually for each change of geomagnetic disturbance the organism of volunteers in all points of measurements responds by similar changes in TSC but with a various

relation of amplitudes. Such coincidence is observed even at low levels of geomagnetic disturbance (the geomagnetic field is considered to be disturbed if the daily value of Kp-index exceeds 18 rel. units). Thus, the global effect on CVS of a human being in the points of observation removed from each other at a distance of the order of 6000 km from each other is observed.

In Fig. 2 the changes of CVS state (TSC) of the volunteers' group in Yakutsk, and also space weather parameters are presented: the Kp-index of geomagnetic disturbance, the total intensity of the interplanetary magnetic field vector (total F), solar wind speed (V), density of solar wind particles (ρ), dynamic pressure of the solar wind (μmV^2 , m is a proton weight).

As is seen from Fig. 2 virtually all maxima and minima of the given parameters coincide in time of occurrence with the same maxima and minima in the group response of volunteers' TSC. Such almost complete coincidence has been observed for half of volunteers' groups. Another half of volunteers has shown a partial coincidence of TSC with space weather parameters. The best coincidence is observed for TSC with the total F, solar wind dynamic pressure and Kp-index of geomagnetic disturbance. For example, the correlation coefficient between TSC in Yakutsk and Kp-index of geomagnetic disturbance has accounted for 0,6 and it is under condition of the fact that TSC represents not the index of one person but the averaged value (group parameter) of the half of volunteers participating in the experiment.

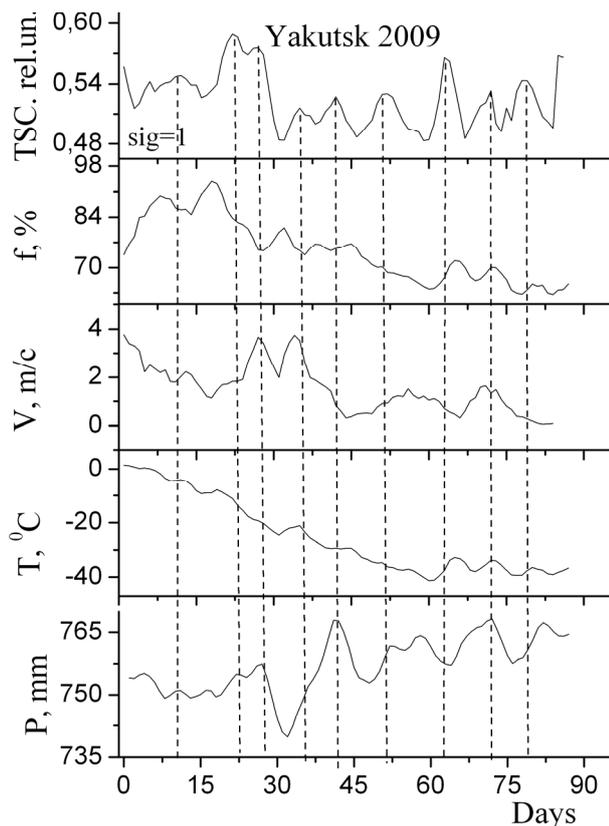


Figure 3: Change of CVS state of a half of volunteer group in Yakutsk with meteoparameters (October 5-December 30, 2009).

It is known that a human being organism reacts to changes of usual Earth's weather. To be convinced whether in this study the usual Earth's weather has influenced or not the state of CVS volunteers we will compare changes of CVS state of volunteers with changes of parameters of usual Earth's weather. Fig. 3 presents changes of the state of CVS of the half of group of volunteers in Yakutsk with meteoparameters (f % is the humidity, V is the solar wind speed, T is the temperature and P is the ground atmosphere pressure). As is seen from Fig. 3 the coincidence of separate changes of each of meteoparameters with TSC is observed.

It means the availability, at best, of only the partial influence of absolute values of meteoparameters on CVS of a human being for the considered period. Besides, in [Samsonov & Manykina, 2012] it was shown that power spectra of space weather parameters and a state of cardiovascular system have shown the complete similarity while power spectra of parameters of usual ground weather have not shown such similarity.

3. Conclusions

1. Studies of connection of space weather parameters with a state of cardiovascular system (CVS) of healthy people on the basis of such observational facts, as:

- the temporal coincidence of maxima and minima in the changes of space weather parameters (without conservation of a relation of amplitudes) with changes of TSC characterizing the state of CVS of a human being in Kiev-Simferopol-Yakutsk;

- the coincidence of only separate maxima and minima in the changes of meteoparameters with changes of TSC in Yakutsk and Tixie

- the availability of set of coinciding period in the power spectra of space weather and TSC parameters ;

- the lack of set of coinciding periods in the power spectra of meteo- and TSC- parameters allows to make a conclusion that just space weather parameters such as the solar wind speed and density, total F transforming in the Earth's magnetosphere into a geomagnetic disturbance are manifested in a state of CVS of a human being at high latitudes.

2. The long evolutionary way of the development of mankind allows a healthy human being to compensate the effect of space weather without an obvious damage of his health at the expense of reserve possibilities of an organism of human being.

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