

# INFLUENCE OF SPACE WEATHER ON A CARDIOVASCULAR SYSTEM OF A HUMAN BEING DURING VARIOUS SOLAR CYCLE PHASES

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**ABSTRACT.** The study of relationship of dynamics of space weather parameters to changes of cardiovascular system state of a human being was carried out by data of measurements of volunteer groups in October – December 2009 and March-April, 2011 by data of Yakutsk and Tixie carried out according to the program of Russian-Ukrainian "Geliomed" project.

It is shown that during a phase of minimum (2009) and growth phase (2011) of the 11-year solar activity a distinction in the response of cardiovascular system of a human being connected with the level of geomagnetic activity, latitude of residing of a human being and his/her age is observed.

**Key words:** solar wind, interplanetary magnetic field, geomagnetic disturbance, cardiovascular system of a human being.

## 1. Introduction

It is known that cardiovascular diseases are one of principal causes of physical disability and death rate of the population. Now it is also known that the considerable contribution to this process is brought by disturbances of space weather parameters and, first of all, parameters of geomagnetic disturbance. The peak absolute values of such disturbance are manifested at high latitudes. So, an experiment on the study of influence of space weather parameters on a cardiovascular system of human being was carried out within the framework of international "Geliomed" project (Vishnevsky et al., 2003) with the participation of volunteer groups in the auroral (settlement of Tixie) and subauroral (city of Yakutsk) zones. The intensity of geomagnetic disturbance changes in the 11-year cycle, so in this work the results of experiments obtained during a phase of minimum and growth phase of the 11-year solar activity cycle are given.

## 2. Experimental data and methods of registration

The experiment on the study of state of the cardiovascular system of volunteers depending on space weather parameters with the express – cardiograph ("Fazagraf") was carried out with groups of volunteers in Yakutsk and Tixie during the following time periods: October-December, 2009 (phase of the 11-year solar activity (SA) cycle minimum) and March-April, 2011 (growth phase of SA).

Measurements were carried out every day at two points of the city of Yakutsk: at Yu.G.Shafer Institute of Cosmophysical Research and Aeronomy (IKFIA) and Medical Institute of M.K.Ammosov North-Eastern Federal University (MI), and also at the Polar Geophysical Observatory belonging to IKFIA in the settlement of Tixie using the same equipment (a Fazagraf complex) according to a common report of investigation with a group of volunteers enrolled at each point of observation. Data of the first lead of volunteers' electrocardiograms (ECG) with a subsequent calculation of T-wave symmetry coefficient (TSC) characterizing a functional state of cardiovascular system of a human being (Fainzilberg, 1998) was used. The data of the solar wind (speed, density, and dynamic pressure), interplanetary magnetic field (magnitude and three orthogonal components), and geomagnetic activity (Kp-index) were used as an index of space weather parameters.

The total number of volunteers participated in the experiment of 2009 was 45 persons, and in 2011 there were 47 persons of various age, sex and physical health. During the experiments on working days the volunteers' ECG were carried out with the Fazagraf device.

### 3. Results and Discussion

The experiment of 2009 showed that the considerable number of maxima and minima of space weather parameters coincided in time of occurrence with the same maxima and minima in a group response of volunteers' TSC. In particular, 88 % of maxima and minima of Kp-index coincided in time of occurrence with the same maxima and minima in a group response of volunteers' TSC. Such almost complete coincidence was observed for a half of volunteers' groups in Yakutsk (14 persons of middle age of 35-years old from a group of 29 persons). Another half of volunteers (15 persons of middle age of 48-years old) showed a partial coincidence of TSC with space weather parameters. The best coincidence was observed for TSC with the magnitude of interplanetary magnetic field, dynamic pressure of the solar wind and Kp-index of geomagnetic disturbance. For example, the correlation coefficient between TSC in Yakutsk and Kp-index was 0.6, and it was on condition that TSC represented not the index of one person but the averaged value (group parameter) of a half of volunteers participating in the experiment. In this case, in Tixie the coincidence of maxima of the Kp-index and TSC accounted for 66%. Conceivably a lower percent of coincidence in Tixie (auroral zone) might be connected with the fact that the highest absolute values of geomagnetic disturbance were observed there, and a part of volunteers living there did not yet attain a sensitivity threshold to the external action.

It is known that an organism of a human being responds to changes of usual ground weather. In order to be convinced that in the given investigation the usual ground weather influenced or did not influence on a cardiovascular system of volunteers, we have compared their changes with changes of usual ground weather parameters. Such a comparison and low values of correlation coefficient have shown that just those parameters of space weather, not of usual ground weather influenced on the cardiovascular system state of volunteers (Samsonov et al., 2013).

The experiment of 2011 (growth phase of the solar activity cycle) was carried out in March-April at values of a 24-hourly coefficient of geomagnetic disturbance up to 35 units, i.e. the geomagnetic disturbance was higher than in 2009. In this case the coincidence of temporary changes of TSC of volunteers in the group of MI (87 % of coincidences) in Yakutsk (middle age of participants is 22 years) and TSC of a half of volunteer group in Tixie (80 % of coincidences; middle age is 40 years) with Kp-index changes was observed. Another half of participants in Tixie (middle age is 43 years) showed only a partial coincidence. A group of IKFIA (middle age is 48 years) in Yakutsk showed only a partial coincidence of dynamics of changes of TSC of volunteers with changes of space weather parameters.

It is known that external actions on biological objects are manifested in the form of quasi-logarithmic dependence (Garkavi et al., 1998). Moreover, this dependence describes experimental data observed by us very well.

The Figure presents a supposed dependence of cardiovascular system state of a human being on the level of geomagnetic disturbance. It consists of three sections. In the first section the change of geomagnetic disturbance leads to a similar change in the response of cardiovascular system (TSC) of a human being so in 2009 we observed a coincidence of changes of the level of geomagnetic disturbance with TSC in Yakutsk and Tixie both for young people and people of elder age.

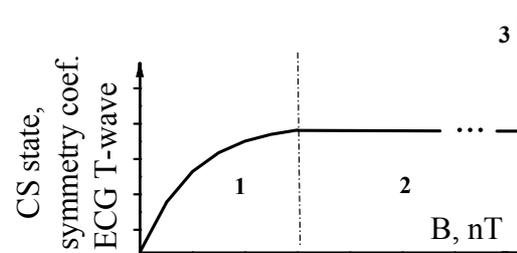


Figure: Dependence of cardiovascular system state of a human being on the level of geomagnetic disturbance

The increase of geomagnetic disturbance leads to the section 2 at which TSC does not increase with the growth of geomagnetic disturbance. Perhaps, it is connected with the attainment of maximum permissible parameters of the cardiovascular system state allowing it to function in a safe regime for life. In this case, in 2011 the coincidence of changes of geomagnetic disturbance only with the MI group (average age is 22-years old) in Yakutsk and a half of younger part of group in Tixie was observed. It means that younger people in Yakutsk and Tixie are in the section 1, and people of elder age are in the section 2. If the geomagnetic disturbance will attain the section 3, then the adaptive capacities of organism cannot cope with such external action and catastrophic consequences for the cardiovascular system of a human being can occur.

Thus, one can assert that the response of cardiovascular system of a human being is connected with the level of geomagnetic activity, latitude of residing of a human being and his/her age.

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### References

- Vishnevsky V.V. et al.: 2003, *Biomedical technologies and radioelectronics*, **3**, 3.
- Garkavi L.Kh. et al.: 1998, Moscow.: IMEDIS, 656.
- Fainzilberg L.S.: 1998, *Operating systems and machines*, **4**, 40.
- Samsonov S.N. et al.: 2013, *Odessa Astron. Publ.*, **26/2**, 300.