

SPACE WEATHER PARAMETERS CAPABLE OF INFLUENCING HEALTH OF A HUMAN BEING

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ABSTRACT. Space weather is a state of Earth-orbital space. The Sun and cosmic rays of high energy affect this state. As the main contribution to a space weather state is made exactly by the Sun then changes of solar activity parameters, and also the changes of geophysical parameters caused by such influence have been considered in this study. A condition of cardiovascular system of a person of volunteer groups has been considered as a condition of health of a human being. An experiment has been carried out within the framework of Russian-Ukrainian project "Geliomed" (<http://geliomed.immsp.kiev.ua>) [Вишневецкий и др., 2009]. It has been found both the immediate influence of electromagnetic solar radiation and the influence of parameters of solar wind and interplanetary magnetic field on a condition of cardiovascular system of a human being mediated through geophysical parameters.

Key words: space weather, solar activity, solar wind, cardiovascular system of a human being, geophysical parameters, interplanetary magnetic field.

Introduction

It is known that the change of conditions in the environment influences a condition of health of a human being. The cardiovascular system, one of the first, joins in the process of adaptation to changing exterior conditions and, consequently, it is the indicator of such influence.

The term «space weather», put into practice for the last years, means a state of Earth-orbital space. The main influence on the state of Earth-orbital space is given by the Sun. One of the fundamental problems of contemporary science is revealing of relationship mechanisms of the solar activity to the functioning of various objects of the biosphere including a human being.

Biological objects on the Earth are under a constant action of environment factors. These are widely known meteorological factors and less known electromagnetic nature factors. Because of the topology peculiarity of magnetic shell of the Earth the changes of factors related

to the Earth's magnetic field have the greatest value at high latitudes. Therefore, in this work the main attention will be given to studies in auroral and subauroral latitudes.

Experimental data and registration methods

The following solar activity parameters: the electromagnetic waves (X-rays and radio- ranges), charged high-energy particles, solar wind (speed, concentration and dynamic pressure), interplanetary magnetic field, and also geophysical activity (geomagnetic disturbance) have been considered as space weather factors. The daily meteorological data (pressure, temperature, humidity and wind speed) as parameters of usual ground weather have been used. The data on space and usual ground weather have been obtained from the Internet. An index of cardiovascular diseases is the number of calls around Yakutsk for the medical care by reason of the following diagnosis: HD - hypertensive disease; HC -hypertensive crisis; DR -patients registered in a dispensary. To define the functional state of cardiovascular system of a person the heart rhythm of volunteers has been measured in Yakutsk and Tixie with the express cardiograph "Fazagraf".

Results and discussion

In the earlier published paper [Самсонов и др., 2005] it has been shown that 2-4 days before a geomagnetic disturbance on the Earth the maximum number of calls for the medical care by reason of cardiovascular diseases is observed. The analysis of given fact has allowed to find out the fact that this maximum is related to the disturbance on the Sun. Then a question about what kind of solar activity parameters can provide a prompt (within 24 hours) influence on a human being on the Earth has appeared. For example, electromagnetic radiation (propagated up to the Earth in 8 minutes) and protons with the energy from 10^6 up to above 10^9 eV (propagated to the

Earth from 15 minutes up to a few hours depending on energy) could be such parameters.

To reveal the definite physical parameters of solar activity responsible for the occurrence of maxima of calls for the medical care, the comparison of solar energy proton fluxes and also electromagnetic radiation of various periods (radio emission and X-rays) with medical indices has been carried out. All specified solar activity parameters have been treated using a superposed epoch technique. In this case, dates when the K-index of geomagnetic disturbances exceeded the value of 30 units (24 events for 1992) have been taken for a zero day.

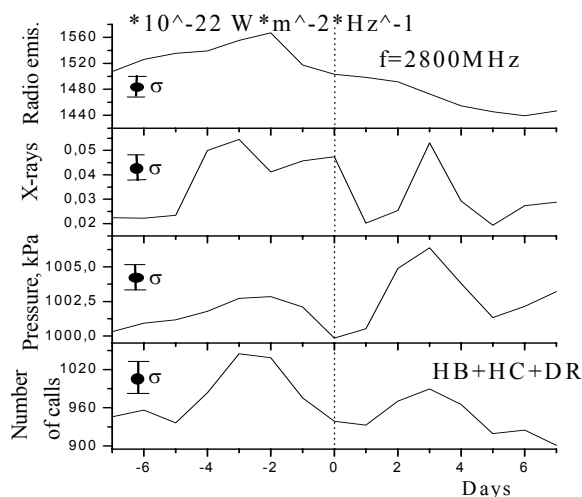


Figure 1: Dynamics of the change of radio emission and X-rays of the Sun, ground pressure and calls for the medical care for patients suffering from cardiovascular diseases relative to the geomagnetic disturbances

The treated data of solar electromagnetic radiation have been compared with the data of the number of calls for the medical care for patients suffering from the cardiovascular pathology. In the energy proton fluxes the presence of maximum at the moment of solar disturbance (2-4 days before the maximum in a geomagnetic disturbance) and maximum in 2-4 days after geomagnetic disturbance has not been revealed. At the same time in the solar electromagnetic radiation, i.e. in the intensity of radio emission with a wave of 10,7 cm length, and also in the X-rays with a wave of (0.5-8.0) nm length which are shown in Fig.1, the features coinciding with changes of the number of calls for the medical care for the patients suffering from a cardiovascular pathology have been found out. As is seen from Fig.1 both in the radio emission and in the X-rays there is a maximum coinciding with the first maximum in the medical indices. Besides, in the X-rays there is a maximum on the third day after the geomagnetic disturbance which coincides with the second maximum in the calls for the medical care. Besides, in the data of ground atmospheric pressure there are both maxima coinciding in time with maxima of calls for the medical care. The coincidence of maxima in the number of calls for the medical care with maxima in the electromagnetic solar radiation and maxima in the ground atmospheric pressure has demanded to clarify what kind of two factors: space

or atmospheric (or both of them)one influences on a state of cardiovascular system of a human being.

Therefore, a special experiment on a group of volunteers numbering 45 persons in Yakutsk and Tixie was carried out. Every day instrument's indications of electrocardiogram of volunteers with the express - cardiograph "Fazagraf" were read. The symmetry coefficient of T-wave (SCT) of the electrocardiogram as an index of condition of cardiovascular system of a human being was used. The opportunity to use the SCT as an index of condition of cardiovascular system of a human being is shown in [Файнзильберг, 1998; Вишнеvский и др., 2003]. Thus, for each patient the individual series of the data for the October 5, 2009 to December 30, 2009 experiment period has been obtained.

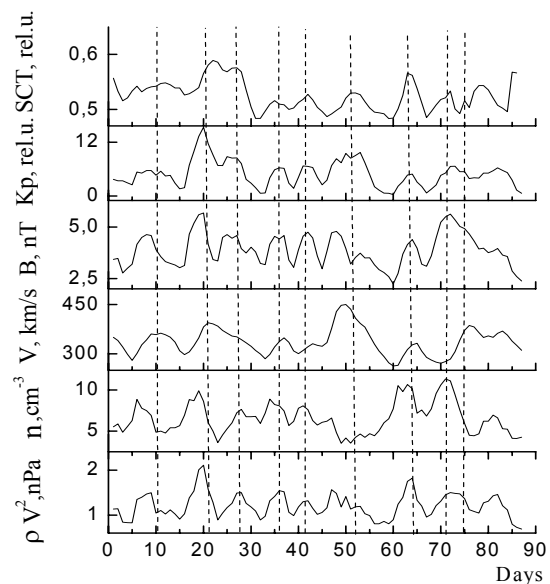


Figure 2: Changes of a condition of cardiovascular system of a half of volunteer group in Yakutsk and space weather parameters

Fig.2 presents SCT in Yakutsk, and also the following space weather parameters: Kp-index of geomagnetic disturbance, B – total intensity of the interplanetary magnetic field, V - solar wind speed, n – particle concentration of the solar wind, ρV^2 – solar wind dynamic pressure.

As is seen from this Figure almost all maxima and minima of the given parameters coincide in time of occurrence with the same maxima and minima in the group reaction of SCT of volunteers in Yakutsk. The experiment in Tixie has shown the same results (Figure is not shown because of limitation of paper space).

Such almost complete coincidence has been observed for a half group of volunteers in Yakutsk (12 persons) and Tixie (10 persons). Other halves of volunteers (11 persons in Yakutsk and 11 persons in Tixie) have shown a partial coincidence of SCT with space weather parameters, and 1 person did not have any coincidence with SCT. The best coincidence is observed for SCT with the total intensity of interplanetary magnetic field, solar wind dynamic pressure and the Kp-index of geomagnetic disturbance.

For example, the correlation coefficient between SCT in Yakutsk and the Kp-index is 0,55 and this fact is under the condition that SCT represents not the index of one person but the average value (group parameter) of a half of volunteers participating in the experiment.

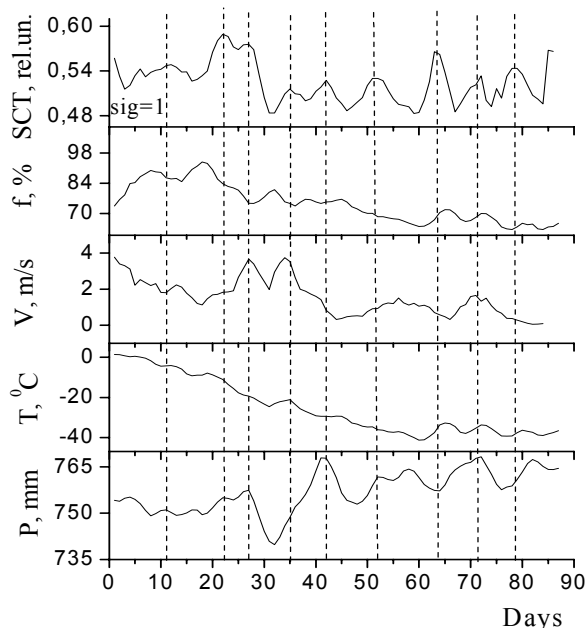


Figure 3: Change of the condition of cardiovascular system of a half of volunteer group in Yakutsk depending on meteoparameters

Then the change of condition of cardiovascular system of volunteers with meteoparameters has been compared. Fig.3 presents the changes of SCT of the group of volunteers in Yakutsk and meteoparameters: f % - humidity, V - wind speed, T - temperature and P - pressure of the ground atmosphere. As is seen from this Figure the coincidence of only separate changes of each of meteoparameters with SCT is observed. It means the presence of only partial influence of absolute values of meteoparameters on cardiovascular system of a person for the considered period at the best. The experiment in Tixie has shown the same results (Figure is not shown because of limitation of paper space).

Thus, it has been shown that the condition of cardiovascular system of a human being in the experiment carried out is connected, first of all, with the space weather parameter.

Conclusions

The study of connection of space weather parameters with a condition of cardiovascular system of a human being has allowed to find out that:

1. Dynamics of electromagnetic disturbances on the Sun (radio emission and X-rays) coincides with the dynamics of the number of calls for medical care by reason of cardiovascular diseases that indicates to the possible influence of electromagnetic solar emission on cardiovascular system diseases of a human being.

2. Coincidence of change of solar wind parameters, such as the density, speed and dynamic pressure of the solar wind, and also the total intensity of the interplanetary magnetic field and geomagnetic disturbance with a condition of cardiovascular system of a human being also indicates to the influence of space weather parameters on a condition of cardiovascular system of a human being.

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