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A NEW APPROACH TO PREDICTION AND ESTIMATE OF HSS-ASSOCIATED ENHANCEMENTS OF "KILLER" ELECTRON FLUX AT GEOSYNCHRONOUS ORBIT

Abstract

So-called "killer" electrons are electrons of relativistic energies (more than 1–2 MeV) forming the outer radiation belt. Their fluxes present a serious threat for on-board electronics of spacecraft orbiting in geosynchronous orbit. This provides actuality of the problem of electron flux forecast. The population of energetic electrons grows after immersion of the Earth's magnetosphere into a high-speed stream (HSS) of the solar wind. The main mechanism of acceleration of magnetospheric electrons to relativistic energies assumed to be their wave-particle interaction with the ULF or VLF waves. Accordingly, the previously proposed prognostic methods were based on the connection of the outer radiation belt population with the speed of the solar wind and the activity of the low-frequency waves in the magnetosphere. That is, almost all of them are statistical models. In this paper, we propose to build a forecast based on phenomenological model. For constructing a phenomenological model of a certain system, such an equation is chosen which is sufficiently simple for an analytical investigation but, at the same time, describes the system behavior fairly adequately. A good example of such a model is a phenomenological model of Burton et al. (JGR 80, 4204, 1975) for the evaluation of the DST index based on interplanetary data. Analogous to this model, we propose to consider the storm-associated electron flux variation as the output of a dynamical system. Such a system should include processes of replenishment of the outer radiation belt due to the acceleration of seed electrons as well as processes of the devastation of the electron flux in the geosynchronous region due to outward adiabatic transport and outward radial diffusion. To characterize these processes, we use the following set of parameters measured on the ground and in situ: the solar wind speed, density and dynamic pressure of the interplanetary plasma, the intensity of ULF oscillations in front of the magnetosphere, at $L = 6.6$, and on the ground, the flow of seed electrons (of hundreds eV energy) at geosynchronous orbit, the difference between the model and the actual values of the magnetic field at $L = 6.6$, and others. Coefficients in the model equation are derived from experimental data using the least-squares method. The main objective of this work is in the problem statement. Preliminary results of the test calculations have shown promising approach. Forecast error does not exceed the values typical of statistical models.