# COSRAD complex of interactive programs for prediction of space radiation environment and radiation effects onboard spacecraft

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Nowadays there are several information systems like CRÈME (http://creme96.nrl.navy.mil), SPENVIS (http://www.spenvis.oma.be/spenvis) and OMERE (http://www.trad.fr). They unite numeric models for calculation of radiation environment and radiation effects onboard satellites and space stations. The current work presents the Russian program complex (named COSRAD) developed in SINP MSU for the same purpose. COSRAD allows to calculate energy spectra of averaged and maximal fluxes of trapped electrons and protons and fluxes of galactic and solar cosmic rays for long-term flights. COSRAD compute energy spectra of the average and maximal fluxes of trapped electrons and protons, and also streams of particles of galactic and solar space beams for long-term space orbital flights (from 1 to 20 years of flight).

Algorithms for calculation of particle fluxes are based on

- the Tsyganenko89 model of magnetic field in which the DGRF model for a modern epoch (2000) is used [1],
- maps of protons (AP8) and electrons (AE8) fluxes depending on LB-coordinates [2],
- the dynamic model of GCR particle fluxes including of a low-energy component of a solar origin [3],
- the probability model of SEP particle fluxes [4],
- the calculated procedure for function of penetration of cosmic ray fluxes inside the Earth magnetosphere [5].

Particle fluxes calculated for “open space” are used to compute energy spectra and LET spectra (for GCR and SEP only) of particle fluxes behind Al spherical shielding with defined depth (from 0.01 to 100 g/cm$^2$) taking into account a generation of secondary protons and neutrons. These spectra serve as the initial data for forecasting the adsorbed or equivalent dose and the SEU rate (number) in integrated circuitries of an onboard equipment. To compute the SEU rate algorithms of the generalized model [6] which takes into account as direct (from ions), and nuclear (from protons) mechanisms of SEU occurrence are used.

The interactive version of COSRAD is placed on a site http://smdc.magnetosphere.ru/. Results of computations are written in text files which can be kept on a local computer and then can be used for the analysis of results.

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