SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration - Part 2 (3B)

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MODELS OF THE MARS RADIATION ENVIRONMENT

Abstract

Models of radiation environment induced by Galactic Cosmic Rays (GCR) and Solar Particle Events (SPE) on Mars have been developed. The work is described as models of incoming cosmic and solar primary particles at Mars transported through the atmosphere down to the surface, with topography and backscattering taken into account, then through the subsurface layers, with volatile content and backscattering taken into account, eventually again through the atmosphere, and interacting with some targets described as material layers. The atmosphere structure has been modeled in a time-dependent way, the atmospheric chemical and isotopic composition over results from Viking Landers. The surface topography has been reconstructed with a model based on Mars Orbiter Laser Altimeter (MOLA) data at various scales. Mars regolith has been modeled based on orbiter and lander spacecraft data from which an average composition has been derived. The subsurface volatile inventory (e.g. CO2 ice, H2O ice), both in regolith and in the seasonal and perennial polar caps, has been modeled vs. location and time. Models for incoming particles for both GCR and SPE are those used in previous analyses as well as in NASA radiation analysis engineering applications, rescaled for Mars conditions.

Particle transport computations were performed with a deterministic (HZETRN) code adapted for planetary surfaces geometry and human body dose evaluations. Fluxes and spectra for most kinds of particles, namely protons, neutrons, alpha particles, heavy ions, pions, muons etc., have been obtained.

Neutrons show a much higher energy tail than for any atmosphereless bodies. Results have been obtained for different surface compositions: only at the latitudes closer to the equator the soil is mostly silicatic regolith, whereas for northern locations a suitable mix, with variable ice concentration with time, of ices of water and carbon dioxide needs to be used. Results have been calculated for different locations and atmospheric properties models. The results obtained with these models differ from those from other models obtained with a simplified model of the Martian atmosphere (single composition, single thickness, no time dependence) and with a regolith-only (no-volatiles) surface model. This Mars Radiation Environment Model will be tested against spacecraft data (e.g. LIULIN-PHOBOS onboard the PHOBOS SAMPLE RETURN spacecraft from the Russian Space Agency RKA, IRAS onboard the EXOMARS lander of the European Space Agency ESA).