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# UPDATED MODELS FOR THE LUNAR AND THE MARTIAN RADIATION ENVIRONMENTS

**Abstract**

In view of the new manned and unmanned space missions to the Moon and Mars, a tool, allowing the computation of radiation particle fluxes and doses at any time and everywhere on, above and below the lunar and Martian surfaces, has been improved with updated geophysical environmental descriptions. Incoming cosmic and solar primary particles are impinging on the lunar surface, transported through the subsurface layers, with backscattering taken into account, and interacting with some targets described as material layers. The same for Mars, with a time-dependent model of the atmospheric structure taken into account. Time dependent models for incoming particles for both GCR and SPE are those used in previous analyses as well as in NASA radiation analysis engineering applications. The lunar surface and subsurface has been modeled as regolith and bedrock, with structure and composition taken from the results from spacecraft, as well as from ground-based radio-physical measurements. This Moon radiation environment model has been validated as well by comparison with results from Monte-Carlo techniques as well as by spacecraft data. For Mars the particles at Mars are 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, both in regolith and in the seasonal and perennial polar caps, has been modeled. The Moon model has been updated by using a new lunar topography model obtained from data of the NASA LRO spacecraft, obtained from stereo imagery and laser altimetry data, with a spatial resolution of the order of 100 m and an altitude resolution of about 20 m or better. This new dataset provides a way of obtaining a much finer grid for radiation patterns which allows more detailed analyses. The Mars model has been updated with better descriptions of the subsurface environment at different Martian locations, with results for the Martian subsurface by this model reported for the first time.