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UPDATED MODELS FOR THE LUNAR RADIATION ENVIRONMENT

Abstract

In view of possible manned missions to the Moon, for which radiation exposure is one of the greatest challenges to be tackled, a tool, which allows the determination of radiation fluxes and doses at any time and at any point of the lunar surface, available has been improved with updated geophysical lunar environment descriptions. Models of radiation environment due to Galactic Cosmic Rays (GCR) and Solar Particle Events (SPE) on the Moon had been developed, and fluxes and doses hereby computed. 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. 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 of the instruments of the Luna, Ranger, Lunar Surveyor and Apollo missions, as well as from ground-based radio-physical measurements. In order to compare results from different transport techniques, particle transport computations have been performed with both deterministic (HZETRN) and Monte Carlo (FLUKA) codes with adaptations for planetary surfaces geometry and human body and organ dose evaluation. A good agreement is shown between results from deterministic and Monte Carlo radiation transport techniques. GCR-induced backscattered neutrons are present at least up to a depth of 5 m in the regolith, whereas after 80 cm depth within regolith there are no neutrons due to SPE. This Moon radiation environment model has been validated as well by spacecraft data (RADOM micro-dosimeter onboard the CHANDRAYAAN-1 spacecraft from ISRO). The 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 and evaluations. Values for various kinds of doses have been obtained for mission scenarios and shielding patterns above, on and below the Moon surface.