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Radiation Effects and Risks in Human Space Missions (4)

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PROBABILISTIC ASSESSMENT OF RADIATION RISK FOR ASTRONAUTS IN SPACE MISSIONS

Abstract

Accurate predictions of the health risks to astronauts from space radiation exposure are necessary for enabling future lunar and Mars missions. Space radiation consists of solar particle events (SPEs), comprised largely of medium energy protons, (less than 100 MeV); and galactic cosmic rays (GCR), which include protons and heavy ions of higher energies. While the expected frequency of SPEs is strongly influenced by the solar activity cycle, SPE occurrences themselves are random in nature. A solar modulation model has been developed for the temporal characterization of the GCR environment, which is represented by the deceleration potential, ϕ. The risk of radiation exposure from SPEs during extra-vehicular activities (EVAs) or in lightly shielded vehicles is a major concern for radiation protection, including determining the shielding and operational requirements for astronauts and hardware. To support the probabilistic risk assessment for EVAs, which would be up to 15% of crew time on lunar missions, we estimated the probability of SPE occurrence as a function of time within a solar cycle using a non-homogeneous Poisson model to fit the historical database of measurements of protons with energy > 30 MeV, $\Phi 30$. The resultant organ doses and dose equivalents, as well as effective whole body doses for acute and cancer risk estimations are analyzed for a conceptual habitat module and a lunar rover during defined space mission periods. This probabilistic approach to radiation risk assessment from SPE and GCR is in support of mission design and operational planning to manage radiation risks for space exploration.