NEW RESULTS FROM THE MSL-RAD EXPERIMENT ON THE CURIOSITY MARS ROVER

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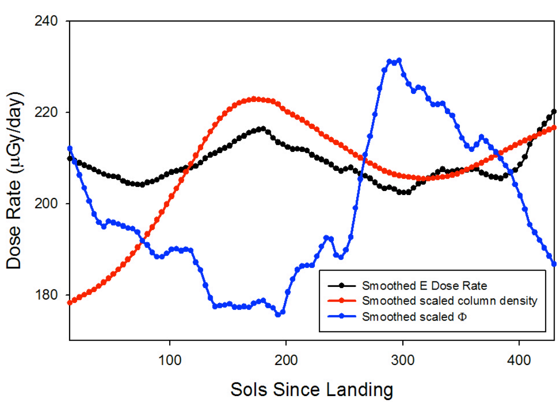
INTRODUCTION

RAD, the Radiation Assessment Detector [1], has been operating successfully on Mars since Curiosity landed in August 2012. RAD is an energetic particle detector capable of measuring all charged particles that contribute to the radiation health risks that will be faced by future explorers to the Red Planet. In addition, RAD can measure high-energy neutrons (from about 8 to 200 MeV) that also make important contributions to the radiation hazard. RAD is used as a dosimeter [2, 3] for both charged and neutral particles [4], and is also a spectrometer that measures charged particle fluxes as functions of species and energy [5]. The energy range of these measurements is constrained by the low mass of RAD, but spectra in the range from about 10 to 100 MeV/nuc are measured for protons and helium nuclei, with higher energy ranges for heavier particles. In addition to the data obtained on the surface of Mars, RAD measured the radiation environment inside the MSL spacecraft during the transit to Mars, providing an additional important data set for planning of future missions that involve travel in shielded vehicles through interplanetary space. RAD data will play a key role in the validation of radiation transport models used to predict future exposures in various mission scenarios. Of particular importance are detailed comparisons between model predictions and spectral data for various particle types (e.g., protons, neutrons, helium ions, and heavier ions).

HIGHLIGHTS FROM THE SURFACE MISSION

MSL landed on Mars at a time that had been predicted to be near the maximum of Cycle 24 solar activity. However, the Cycle 24 maximum has proven to be extraordinarily weak by historical standards, resulting in GCR dose rates that are higher than would have been expected based on previous cycles. Data taken over the first 450 sols (24 hours and 37 minutes per sol) indicate that the GCR dose rate on the surface is sensitive both to changes in the large-scale heliosphere and to local changes in atmospheric pressure in Gale Crater. Smoothed data with arbitrary units in the figure below illustrate these trends. In that time, two Solar Energetic Particle events have occurred with sufficiently hard spectra to produce a detectable increase in the charged particle flux on the surface. Given that RAD is shielded by about 20 g cm^{-2} of CO_2, these events must have accelerated protons to energies above 150 MeV. Several other solar events have been indirectly observed in the form of Forbush decreases, which are suppressions of energetic particles caused by short-term changes in the interplanetary magnetic field arising from Coronal Mass Ejections. RAD has also observed clear diurnal signals [5] in total dose, heavy ion flux, and neutron flux. These diurnal effects are directly attributable to the significant daily changes in the column depth of atmosphere above RAD. Deconvolution of neutral particle spectra into gamma-ray and neutron spectra has been performed for data taken over the first 100 sols [4] and will be presented. The dose equivalent contribution from neutrons in the range of RAD's sensitivity is found to be about 10% of the total.



REFERENCES

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