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Introduction: The Lunar Exploration Neutron Detector (LEND) onboard Lunar Reconnaissance Orbiter (LRO) [1] measures the flux of neutrons from the lunar surface, produced by the bombardment within the surface by Galactic Cosmic Rays (GCR) whose variability is associated with the Solar Cycle. The objective of this paper is to make an assessment of the effect of solar activity on the neutron flux radiated by the moon. The model will be then checked against the LEND data gathered during 2009-2011 period, as well as against other relevant observations such the neutron data collected at Mars and Earth.

Approach: In our analysis we use the results by *McKinney et al*. [2] who computed the lunar differential neutron leakage by using MCNPX code with the flux of galactic cosmic rays (GCR) as an input. The model results were then checked against *in situ* neutron measurements made during the Apollo 17 mission. The Apollo 17 Lunar Neutron Probe Experiment (LPNE) provided a unique set of in situ data on the production of neutrons within the top 2 meters of the Lunar regolith bombarded by GCR, and serves as an invaluable "ground-truth" in the age of orbital remote sensing. Moreover a model of the GCR flux was presented in [3, 4] where the key role is played by the solar modulation potential Φ which describes the effect of solar magnetic field on the GCR flux. The potential ranges from 100 MeV in a local interstellar medium to more than 900 MeV in periods of Solar Grand Maximum [4].

Results: The initial phase of LRO mission 07/09 – 05/10 took place during the period of a very quiet sun. As suggested by [4] since Φ = 100 MeV is used for a local interstellar spectrum, such modulation potential could be used during extreme solar minimum periods such as the Maunder Minimum (1645-1715). Moreover the analysis [5] shows that the current solar cycle is similar to the three cycles that occurred during the Dalton minimum in the early nineteenth century. The minima of those cycles could be described by the potential Φ = 200-250 MeV which is the average between the absolute minimum of 100 MeV at the Maunder Minimum and a "regular minimum" of 300-400 MeV such as happened in the 1980s and 1990s. The value of Φ = 200-250 MeV can serve as a conservative estimate for the early part of the LRO mission (07/09 – 05/10). Furthermore the total neutron flux was found by integrating the GCR flux with the neutron production rate per particle adapted from [2]. The neutron flux was then obtained as a function of the solar modulation potential. The model was checked against the neutron count rates for each of four collimated LEND sensors collected during LRO mission and against the GCR counts collected by the Mars Odyssey. A good correlation was found between the model results and the temporal behavior of the Lunar and Martian count rates.

References:

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