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Human Exploration of the Moon and Mars: Space Radiation Data, Modeling and Instrumentation Needs

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NASA is planning to return astronauts to the moon and then send them to Mars. Data and modeling of the space radiation environment will be needed to plan these missions and instrumentation will be needed to conduct them safely. This talk will suggest the kinds of data, models and instrumentation that will be needed to plan and support human exploration of the Moon and Mars.

1. Extended Abstract

On January 14, 2004 President Bush announced the Vision for Space Exploration, a program for long-term human and robotic exploration of the solar system which will include a return of humans to the moon not later than 2020, followed by human missions to Mars. Since this announcement, NASA has been developing plans and mission architectures for these human missions as well as robotic precursor missions.

Among the critical needs for research and development in support of this Vision are investigations on the ionizing radiation environment and development of instrumentation to guide NASA in managing the radiation exposure of the crew during the manned missions. For mission planning, models are needed for a reference worst-case solar energetic particle event and a reference worst-case galactic cosmic ray environment.

During Lunar missions it will be necessary to carefully manage the radiation exposure of the crew in real time because of the variability of the radiation environment due to solar activity. In particular, prompt warnings will be needed when large solar energetic particle events occur. Accurate predictions will also be needed of the particle flux and flux history at the moon to support critical mission management decisions.

A new generation of dosimeters and radiation monitors will also be needed to accompany the crew. These instruments must return data in real time so that they can be used in the critical decisions that must be made if a large solar energetic particle event occurs. This is especially true if it occurs during a lunar excursion.

A substantial radiation exposure on extended lunar missions and Mars missions comes from galactic cosmic rays. This exposure must be mitigated by radiation shielding and other measures. During Mars missions the galactic cosmic ray exposure occurs primarily during the cruse phase between the Earth and Mars. This is especially true for opposition class missions. These missions would typically last ~430 days with only 30-90 days on Mars.

Solar energetic particle events are less of a concern on Mars because of its greater distance from the Sun (~1.5 AU) and the partial protection afforded by its atmosphere (~20 g/cm^2).

The talk will describe the current plans for future human missions to Earth orbit, the Moon and Mars. The needs for data and models of the radiation environment and radiation detectors to support these missions will be discussed.