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Radiation environment and Habitability on Mars at Oxia Planum and Mawrth Vallis: influence of mineralogy, atmospheric depth and Solar activity

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Eventual past forms of life on Mars and future human missions have been and will be strongly affected by radiation. Here we present the estimation of the radiation environment (Galactic Cosmic Rays, GCRs, and Solar Energetic Particles, SEPS) and corresponding doses in proxies for biological targets at Oxia Planum, chosen as the landing site for the next ExoMars 2020 mission [1], and Mawrth Vallis, previously a candidate landing site. The study is performed through detailed Monte Carlo particle transport calculations using the dMEREM code [2] based on the Geant4 toolkit [3], for the period of the Halloween storm (October 2003).

The results [4] show that both elevation (and thus atmospheric depth) and mineralogical content influence the doses received at the surface of the two sites. In particular, we find that the spectra of downward GCRs are slightly influenced by differences in the atmospheric depth, while SEPs, being more stopped in the upper part of the atmosphere, have a downward spectrum relatively similar for the two locations. The different behavior of the two types of radiation is also analyzed in their interaction with the regolith. The influence of diurnal variations of the atmosphere on the radiation environment are also studied, and compared with the observations from Curiosity [5]. For the two sites mentioned above and also for Gale Crater, an underestimation of the radiobiological doses can be noted. We speculate that the Monte Carlo particle transport approach partially understimate the radiation damage at lower energies, as also demonstrated by some few previous works, and we present our current efforts in better understanding how to model the effects of radiation across different energy/lengths scales [6].

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