Models and Measurements from Earth to Mars during Artemis-I

T.C. Slaba[1], S. Rahmanian[2], S. George[3], D. Laramore[4], J.W. Norbury[1], C.M. Werneth[1], C. Zeitlin[4]

[1]*NASA Langley Research Center; Hampton, VA 23681, USA*
[2]*Analytical Mechanics Associates; Hampton, VA 23666, USA*
[3]*Johnson Space Center; Houston, TX 77058, USA*
[4]*Leidos Inc., Houston, TX 77598, USA*

For all planned human spaceflight missions, accurate models and measurements are needed to assess human exposure and ultimately project and mitigate associated health risks. During Artemis-I, measurements of the absorbed dose-rate were simultaneously being taken inside the International Space Station (ISS) in low Earth orbit (LEO), inside the uncrewed Orion capsule in free space, inside the BioSentinel CubeSat in free space, and on the Martian surface. These measurements encompass human exploration destinations from Earth to Mars and highly diverse shielding conditions.

Computational models used to assess crew exposure and cancer risk have been extensively compared to spaceflight measurements over the past several decades, but for the most part, only single destinations and shield configurations were considered in each study (e.g. ISS in LEO). Never before have the models been compared to measurements collected *over the same time period* spanning locations from Earth to Mars and shield configurations from CubeSats (14 kg) to space stations (400,000 kg). Such a comprehensive study would be highly useful to establish a clear picture of combined model accuracy and systematic uncertainties.

In this work, combined environment, physics, transport, and shield geometry models are compared to measurements taken during the Artemis-I mission timeframe inside the ISS, Orion capsule, BioSentinel CubeSat, and on the Martian surface. All model calculations were performed blind, without having prior knowledge or access to the measurement data. The combined models are found to be in excellent agreement with measurements. Further improvement to combined model calculations necessitates additional ground-based cross sections measurements to reduce uncertainties for neutron, pion, and light ion (isotopes of hydrogen and helium) production

Please contact the author for further Information.