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An artist's rendering of the Orion spacecraft that NASA is planning to use on future deep-space missions. Credit: NASA Orion Spacecraft, CC BY-NC-ND 2.0 (bit.ly/ccbynd2-0)

In a list of the thousands of lucky factors that have enabled life to flourish on Earth, the planet's magnetism should rank somewhere near the top. Earth's magnetic field acts as a kind of shield, protecting the surface from a constant stream of solar energetic particles (SEPs) that cause mutations to DNA that would make life as we know it impossible. This radiation poses a real danger to astronauts who leave the protection of Earth's magnetic field.

Ordinarily, the risk of solar radiation to deep-space travelers is relatively low and constant, a steady background of small doses. But occasionally, following space weather events like coronal mass ejections, the Sun can release a much denser barrage of SEPs that greatly amplifies the danger to human health—the same way a quick, torrential downpour will soak you more thoroughly than a long, misty morning. As NASA plans longer missions deeper into space, researchers are trying to understand what type of risk these acute bursts of SEPs will pose to astronauts.

Here *Mertens et al.* demonstrate a new system of models that could help show, in real time, both how many SEPs astronauts are exposed to and how much damage the exposure could cause to our biology. The researchers designed the project specifically for NASA's Orion Multi-Purpose Crew Vehicle, which the agency plans to use in future missions to the Moon and Mars. To calculate how much radiation an astronaut is exposed to, the first model draws data from six dosimeters—sensors that detect incoming radiation—placed around the inside of the craft in the same locations the crew would be found. A second model then translates the exposure into biological risk, especially in blood-forming organs (bone marrow, thymus, spleen), which are the most sensitive to radiation. This second model also shows how the radiation exposure may negatively affect an astronaut's performance during the mission.

This system of models is slated for use on upcoming missions. Researchers have not yet been able to test it, however, in a deep-space SEP event. Instead, they ran a simulation using data drawn from various satellites during a historically dangerous SEP event in October 1989. In this simulated experiment, the researchers report, the models performed well, averaging 33% uncertainty across the duration of the event.

Although these results are encouraging, the researchers note that these experiments assume that the incoming radiation is isotropic, meaning that it comes from all directions in a relatively equal distribution, whereas actual incoming radiation is anisotropic. The authors are planning future work to assess how anisotropy influences uncertainty in the organ dose model, a vital question if humanity plans to explore space beyond the protection of Earth's magnetic field. (*Space Weather,* https://doi.org/10.1029/2018SW001971, 2018) **—David Shultz, Freelance Writer**