Sun delivered curveball of powerful radiation at Earth

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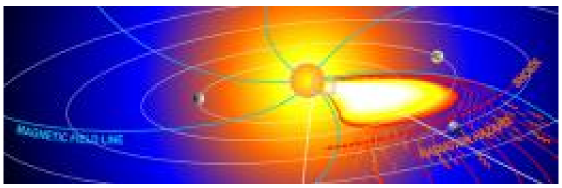

Particle radiation from the Jan. 23, 2012 solar flare speeds away from the Sun along curved magnetic field lines (blue lines) and arrives before the coronal mass ejection (orange mass from the Sun) and its driven shock. Image courtesy of Nathan Schwadron, UNH-EOS.

A potent follow-up solar flare, which occurred Friday (Jan. 17, 2012), just days after the Sun launched the biggest coronal mass ejection (CME) seen in nearly a decade, delivered a powerful radiation punch to Earth's magnetic field despite the fact that it was aimed away from our planet.

According to University of New Hampshire scientists currently studying and modeling various aspects of solar radiation, this was due to both the existing population of energetic particles launched by the first CME and a powerful magnetic connection that reeled particles in towards Earth from the Sun's blast region, which had spun to an oblique angle.

"Energetic particles can sneak around the 'corner,' as was the case in Friday's event when it was launched at the Sun's limb, or edge," says astrophysicist Harlan Spence, director of the UNH Institute for the Study of Earth, Oceans, and Space (EOS) and principal investigator for the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) instrument onboard NASA's Lunar Reconnaissance Orbiter (LRO) mission. CRaTER is designed to measure and characterize aspects of the deep space radiation environment.

Space weather events can disrupt Earth-based power grids, satellites that operate global positioning systems and other devices, can lead to some rerouting of flights over the polar regions, and pose severe risk to astronauts beyond low-Earth orbit.

The first explosion, which occurred Monday, Jan. 23, 2012, fell just short of being rated an X-class flare – the most powerful type of solar storm. When Friday's X-flare exploded from the same sunspot region that was the source of the week's earlier blast, the Sun's west limb was pointing away from Earth.

Nonetheless, the resulting high-energy protons that speed toward Earth even faster than the four-million-mile-per-hour solar wind demonstrated that dangerous "space weather" can affect us even when the planet is not in the direct path.

"The magnetic field lines on which energetic particles travel curve from the Sun to Earth unlike CMEs, which travel in straight lines. In the case of the second flare, energetic particles were magnetically connected to Earth even though the second CME from this active region missed us entirely," explains Madhulika Guhathakurta, lead program scientist of NASA's Living with a Star program.

Notes Spence, "And the situation was worsened, from the standpoint of radiation, because there was a pre-existing energetic particle population, from the first CME, when the second one arrived."

CRaTER's primary goal has been to characterize the global lunar radiation environment and its biological impacts. It does so by measuring galactic and solar cosmic radiation from behind a "human tissue-equivalent" plastic. During the two and a half years the LRO mission has been making measurements, the latest solar events are the most significant with respect to incoming radiation.

"We now have estimates of the dose and can speak to the biological impacts that might have occurred in deep space to astronauts," says Michael Wargo, NASA's chief lunar scientist.

Both events, while strong forms of space weather, were not as powerful as the 2003 Halloween storms, which were the most powerful space weather events of the last 23-year-long solar cycle. But as the Sun moves towards solar maximum in 2013, it may yet have even more powerful storms to deliver as it becomes increasingly violent.

Measurements from CRaTER, and predictions from the UNH Earth-Moon-Mars Radiation Environment Module (EMMREM), whose principal investigator is astrophysicist Nathan Schwadron of the EOS Space Science Center, describe radiation exposure in space, on the Moon, and in planetary environments. The resulting understanding of space radiation hazards becomes evermore critical in studying and predicting the effects of these powerful solar outbursts.

Notes Guhathakurta, "The use of EMMREM to characterize active events highlights our rapidly advancing capabilities for understanding, characterizing, and even predicting the radiation coming from our increasingly active Sun."

Provided by University of New Hampshire