CRATER'S "SEPI" MAP OF LUNAR RADIATION. J. K. Wilson[1,2], H. E. Spence[1,2], N. A. Schwadron[1,2], A. W. Case[3], M. D. Looper[4], A. P. Jordan[1,2], W. de Wet[1], J. Kasper[5], [1]Institute for the Study of Earth, Oceans, and Space, University of New Hampshire, Durham, NH, USA (jody.wilson@unh.edu), [2]Solar System Exploration Research Virtual Institute, NASA Ames Research Center, Moffet Field, California, USA, [3]Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA, [4]The Aerospace Corporation, El Segundo, California, USA, [5]Michigan Institute for Research in Astrophysics, University of Michigan, Ann Arbor, Michigan, USA.

Introduction: We have invented a new method for detecting very small solar energetic particle events [1] using data from the Cosmic Ray Telescope for the Effects of Radiation (CRaTER) [2] on the Lunar Reconnaissance Orbiter (LRO). This "SEP Index" (SEPI) is also highly sensitive to variations in lunar albedo radiation during solar quiet periods. The features in the SEPI map of the Moon represent some combination of lunar albedo protons, neutrons, and gamma rays, which presumably reflect variations in elemental abundances in the regolith. This result will lead to multiple follow-up studies of lunar albedo particles and may also contribute to the study of diurnally varying hydrogenation of the lunar regolith.

Solar Energetic Particle (SEP) Index: Whereas previous lunar mapping studies used the energy deposited by particles that registered in two or more CRaTER detectors [3,4,5,6], the SEP Index uses only the total particle counting rates from four detectors and ignores any energy spectral information. SEPI utilizes the unequal detector shielding within the CRaTER instrument, with data from the least-shielded detectors (D1 and D6) representing the SEP flux, and the most-shielded detectors (D3 and D4) representing highly-penetrating background galactic cosmic ray flux. We derived the formula for the SEP Index empirically by minimizing the variations in the index during solar quiet periods:

$$\mathbf{SEPI = 0.144*D1s/D3s + 0.446*D1s/D4s + 0.792*D6s/D4s}$$

where DNs is the number of detection events in detector N over a given period of time. The index varies by ~1% during quiet periods.

New Lunar Map: During perfectly quiet solar periods we sort SEP Index values by location over the Moon instead of by mission time, thus generating a map of radiation coming from the Moon. The SEPI map most closely resembles Lunar Prospector maps of gamma rays characteristic of thorium, iron, and titanium [7,8]. The map is most anti-correlated with thermal neutron maps [9, 10] and the LP map of gamma rays characteristic of aluminum [7,8]. Figure 1 shows the new map with higher index values represented by darker shades. Since detector D6 faces the Moon and D6s appears in the numerator of one term in the SEPI formula, any higher-flux or lower-flux features that appear in a SEPI map of the Moon are probably due to an enhancement or dearth, respectively, of lunar albedo particles or photons that interact with detector D6 more frequently than detectors D1, D3 or D4. Candidate albedo particles include neutrons, gamma rays, and protons with lower-energies (14-50 MeV) than in previous CRaTER studies.

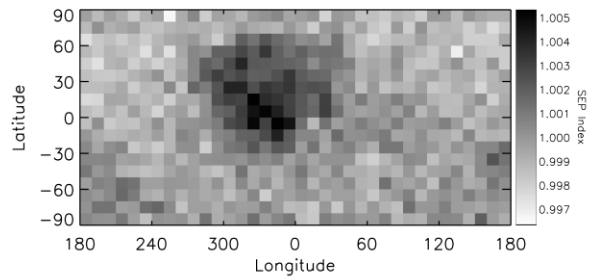

Figure 1. Lunar albedo radiation map using SEP Index derived from CRaTER data. Darker shades represent higher index values. The near side lunar mare (center) and South Pole-Aitken basin (lower corners) both have higher values, suggesting that one or more mare-associated elements can enhance lunar albedo radiation.

References: [1] Wilson et al. (2019), *GRL*, *47*, 10.1029/2019GL085522. [2] Spence et al. (2010), *Space Sci. Rev*, *150*, 243-284. [3] Wilson et al. (2012) *JGR*, *117*, (E12). [4] Wilson et al. (2014) *AGU Fall Meeting*. [5] Schwadron et al. (2016) *Icarus*, *273*, 25-25. [6] Schwadron et al. (2018) *Planet. Space Sci.*, *162*, 113-132. [7] Feldman et al. (2019), Lunar Prospector Reduced Spectrometer Data – Special Products. *[online*]* [8] Prettyman et al. (2002), *33rd LPSC*, Abstract #2012. [9] Feldman et al. (2000), *JGR*, *105*, 20347-20363; Maurice et al. (2004), *JGR*, *109*, E07S04; Elphic et al. (2000), *JGR*, *105*, 20333-20345. [10] Litvak et al. (2012), *JGR*, *117*, E00H22; Litvak et al. (2012), *JGR*, *117*, E00H32.
*https://pds-geosciences.wustl.edu/missions/lunarp/reduced_special.html