



Measurements of Forbush decreases at Mars: both by MSL on ground and by MAVEN in orbit

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The Radiation Assessment Detector (RAD), on board Mars Science Laboratory's (MSL) Curiosity rover, has been measuring ground level particle fluxes along with the radiation dose rate at the surface of Mars since August 2012. Similar to neutron monitors at Earth, RAD sees many Forbush decreases (FDs) in the galactic cosmic ray (GCR) induced surface fluxes and dose rates. These FDs are associated with coronal mass ejections (CMEs) and/or stream/corotating interaction regions (SIRs/CIRs). Orbiting above the Martian atmosphere, the Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft has also been monitoring space weather conditions at Mars since September 2014. The penetrating particle flux channels in the Solar Energetic Particle (SEP) instrument onboard MAVEN can also be employed to detect FDs. For the first time, we study the statistics and properties of a list of FDs observed in-situ at Mars, seen both on the surface by MSL/RAD and in orbit detected by the MAVEN/SEP instrument. Such a list of FDs can be used for studying interplanetary CME (ICME) propagation and SIR evolution through the inner heliosphere. The magnitudes of different FDs can be well-fitted by a power-law distribution. The systematic difference between the magnitudes of the FDs within and outside the Martian atmosphere may be mostly attributed to the energy-dependent modulation of the GCR particles by both the pass-by ICMEs/SIRs and the Martian atmosphere. Such an effect has been modeled via transporting particles of differently modulated GCR spectra through the Martian atmosphere.