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Multi-point observations of Forbush decreases at Earth and at Mars: a statistical comparison and statistics

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During their travel from the Sun to Earth, coronal mass ejections (CMEs) and their interplanetary (IP) counterparts (interplanetary coronal mass ejections, ICMEs) interact with Galactic cosmic rays (GCRs) that fill the IP space. The leading shock wave of the ICME (if any) and the following ejecta modulate GCRs, which results in a reduction in the cosmic ray (CR) intensity, known as the Forbush decrease (FD). On the other hand, high-speed streams (HSS) from coronal holes (CHs) rotate with the Sun, forming Corotating Interaction Regions (CIRs). These can also modulate GCRs and result to FDs. In this work we present FD events that have been recorded at Earth by neutron monitors and at Mars by the Radiation Assessment Detector (RAD) instrument on the Mars Science Laboratory (MSL). We have compiled a catalogue of 424 FDs at Mars using RAD dose rate data, from 2012 to 2016. Furthermore, we applied, for the first time, a comparative statistical analysis of the FDs measured at Mars, by RAD, and at Earth, by NMs, for the same time span. A carefully chosen sample of FDs at Earth and at Mars, driven by the same ICME, led to a significant correlation (cc=0.71) and a linear regression between the sizes of the FDs at the different observing points. We show that the amplitude of the FD at Mars is higher on average by a factor of 1.5-2 compared to the size of the FD at Earth. Finally, almost identical regressions were obtained for both the Earth and Mars FDs as concerns the dependence of the maximum hourly decrease of the CR density to the size of the FD.