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Radar blackouts in Mars' atmosphere produced by space weather events

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The Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) onboard Mars Express (MEX) and the Shallow Radar (SHARAD) onboard Mars Reconnaissance Orbiter (MRO) suffer from severe degradation in the ground reflection signal almost every time a solar energetic particle (SEP) event strikes Mars. The most notable case occurred in September 2017, when the signals of both radars were completely absent for several days. Thanks to the MAVEN mission, we now know that the cause was likely the precipitation of SEP electrons of a few tens of keV, associated with a series of powerful space weather events that struck Mars during 10-22 September 2017. Such energetic electron precipitation is believed to produce a lower ionospheric layer within the collision-dominated atmosphere, which can absorb the radar signal at the radar operational frequencies, around 5 MHz for MARSIS and 20 MHz for SHARAD. In this study, we assess the properties of this low ionospheric layer around the planet based on these radar attenuation estimates. In addition, taking advantage of a larger dataset during over the lifetime of both the MEX and MRO missions, we evaluate when and under which conditions this absorption layer appears. As it is leading to the loss of radar signals at least between 5 and 20 MHz, the outcome of his work will allow better assessment of high frequency radar performance during future space weather events.