A causative mechanism for the extremely enhanced ionization produced by discrete aurora on Mars: MARSIS observations

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Abstract

The Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) experiment onboard Mars Express (MEX) observed a few events of extremely strong ionizations on 15, 21, 28 June and 10 July 2007 at low altitude during the orbit # 4425, 4447, 4469 and 4513 at Ls = 258^o, 262^o, 266^o and 274^o respectively. These observations were carried out in the mini-magnetosphere of Mars between latitude 50^{o}S to 60^{o}S and longitude 175^{o}E to 190^{o}E. The maximum peak electron density ~ 3.75×10^5 cm^{-3} is observed on 15 June 2007 at altitude 88.48 km. Observation of such strong density at this low altitude is unusual and demands a source mechanism. We have found that a solar flare along with the Solar Energetic Particle (SEP) can account together for such strong ionization. For this purpose, we have modelled the electron density profiles using coupled continuity and yield spectrum methods. We have also calculated the ionization rates due to impact of photon, photoelectron and SEP in the dayside atmosphere of Mars. The modelled electron densities agree reasonably well with the MARSIS observations. However, the modelled peak altitudes are somewhat higher than that of the maximum peak electron density observed by MARSIS. We believe that the lack of solar flux observations for the Martian orbit and the limited field of view of particle measurement instrument on MEX made the non-observation of a solar transient event like discrete aurora that might have caused the extremely strong ionization in the Martian lower ionosphere.