EGU21-5649
https://doi.org/10.5194/egusphere-egu21-5649
EGU General Assembly 2021


# Modeling of SEP induced auroral emission at Mars: Contribution of precipitating protons and effects of crustal fields

**Yuki Nakamura**[1,2], Naoki Terada[1], Hiromu Nakagawa[1], Shotaro Sakai[1], Sayano Hiruba[1], Ryuho Kataoka[3], Kiyoka Murase[3], and François Leblanc[2]

[1]Geophysics, Tohoku University, Miyagi, Japan
[2]LATMOS, Sorbonne Université, Paris, France
[3]Space and Upper Atmospheric Sciences Group, National Institute of Polar Research, Tokyo, Japan

Solar Energetic Particle (SEP) and the Imaging UltraViolet Spectrograph (IUVS) instruments on board the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft have discovered diffuse aurora that spans across nightside Mars, which resulted from the interaction of Solar Energetic Particles (SEPs) with Martian atmosphere [Schneider et al., 2015]. Previous models showed that 100 keV monoenergetic electron precipitation should have been at the origin of the low altitude (~60 km) peak of the limb emission, however, no models were able to reproduce the observed emission profiles by using the observed electron energy population [e.g. Haider et al., 2019]. Previous auroral emission models did not take into account the contribution of MeV proton precipitation, although MeV proton can penetrate down to ~60 km altitude as well [e.g., Jolitz et al., 2017]. This study aims to model SEP induced diffuse auroral emission by both electrons and protons.

We have developed a Monte-Carlo collision and transport model of SEP electrons and protons with magnetic fields on Mars. We calculated limb intensity profile of $CO_2^+$ ultraviolet doublet (UVD) due to precipitation of electrons and protons with energy ranging 100eV-100keV and 100eV-5MeV, respectively, during December 2014 SEP event and September 2017 SEP event by using electron and ion fluxes observed by MAVEN/SEP, SWEA and SWIA.

The calculated peak limb intensity of $CO_2^+$ UVD due to precipitation of protons is 3-5 times larger than that due to precipitation of electrons during both December 2014 and September 2017 SEP events, which suggests that protons can make brighter $CO_2^+$ UVD emission than electrons. Peak altitude of limb intensity profiles of $CO_2^+$ UVD due to precipitation of electrons and protons are both 10 - 20 km higher than the observation, a discrepancy could be explained by the uncertainty in the electron and proton fluxes that precipitate into the nightside Mars.

We have tested an effect of crustal field on the emission of $CO_2^+$ UVD. $CO_2^+$ UVD emission due to the precipitating electrons are depleted by a factor of 10 in the region of open crustal field and disappeared in the region of closed and parallel crustal field, whereas emission due to the precipitating protons does not change significantly. Further observations of diffuse aurora in the crustal field region should be needed to constrain the origin of diffuse aurora on Mars.