

R009-26

A 会場 : 11/25 AM2 (11:05-12:35)

11:50~12:05:00

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Study of global SEP precipitation into Martian atmosphere based on PTRIP and MAESTRO models

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The study of aurorae extends beyond Earth to other planets, including Mars, where the diffuse aurora emission is considered to be driven by the precipitation of solar energetic particles (SEPs) into the Martian atmosphere (e.g. Schneider et al., 2015). Jolitz et al. (2021) demonstrated that while SEP protons are minimally affected by magnetic fields, the precipitation of SEP electrons is reduced by both the Martian intrinsic crustal and solar wind induced magnetic fields. Okiyama et al. (2025) recently showed that the magnetic field orientation can alter the vertical profile of diffuse auroral emissions at 75-100 km altitudes caused by the SEP electrons. However, the precipitation mechanism of SEP electrons into the Martian atmosphere during interplanetary coronal mass ejection (ICME) events with disturbed induced magnetospheric conditions is poorly understood. In our study, we combine the PTRIP test particle model (Nakamura et al., 2022) with the MAESTRO Global MHD model for solar wind-Mars interaction (Sakata et al., 2024), employing a strategy of the back tracing of test electrons.

This approach allows for the efficient simulation of the SEP electron precipitation with a good coverage in the phase space. In our simulations, electrons with uniformly distributed initial pitch and phase angles, latitude, and longitude were launched upward from an altitude of 300 km, simulating a September 2017 event (Schneider et al., 2018). The electrons were traced under the influence of magnetic fields obtained from the MAESTRO global MHD simulations until they reached upper or lower altitude boundaries. The results of the back tracings identified three main consequences: upstream escape, tailward escape, and precipitation onto the surface. It implies that we can estimate the global distribution of incident SEP electrons from the results by combination with upstream SEP observations. The estimated distribution of global SEP electron precipitation patterns showed a qualitative match with aurora emission distribution observed by IUVS onboard MAVEN. In the presentation, validation of these results by comparison with observations and estimation of incident SEP electron distribution functions at 300 km altitude will be reported.

References:

- Jolitz, R. D., et al. (2021), J. Geophys. Res. Space Physics, 126, e2021JA029132. <https://doi.org/10.1029/2021JA029132>
Nakamura, Y., et al. (2022), J. Geophys. Res. Space Physics, 127, e2021JA029914. <https://doi.org/10.1029/2021JA029914>
Okiyama, T., et al. (2025). J. Geophys. Res. Space Physics, 130, e2024JA033420. <https://doi.org/10.1029/2024JA033420>
Sakata, R., et al. (2024), J. Geophys. Res. Space Physics, 129, e2023JA032320. <https://doi.org/10.1029/2023JA032320>
Schneider, N. M., et al. (2018), Geophys. Res. Lett., 45, 7391 – 7398. <https://doi.org/10.1029/2018GL077772>