火星電離圏イオンの降り込みに対する太陽風電場の影響

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Effects of the solar wind electric field on heavy-ion precipitations to the Martian upper atmosphere

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The solar wind can directly interact with the Martian upper atmosphere, since Mars does not possess a global intrinsic magnetic field [e.g., *Acuna et al.*, 1998]. Atmospheric escape phenomena induced by the solar wind interaction have been observed by Phobos-2 at the solar maximum, and recently by Mars Express (MEX) at the solar minimum [e.g., *Lundin et al.*, 1989; *Barabash et al.*, 2007]. Escape rates of planetary ions estimated by both spacecraft indicate large dependence on the solar wind conditions [e.g., *Barabash et al.*, 2007; *Lundin et al.*, 2008]. It has been known that escaping planetary ions, which are picked up by interplanetary magnetic field (IMF) in the solar wind, are distributed highly asymmetrically in terms of the convective electric field [*Barabash et al.*, 2007].

The precipitating ions to the upper atmosphere can cause the escape of neutral particles due to the ion sputtering [e.g., *Luhmann et al.*, 1992]. Heavy-ion precipitations up to a few keV onto the Martian atmosphere are discovered by Mars Express (MEX) observations predominantly during CIR passages [*Hara et al.*, 2011]. *Hara et al.,* [2011] suggested the importance of the compressed IMF strength due to CIRs to the enhancement of the heavy-ion precipitations. While the direction of convective electric field in the solar wind should be also important for the picked-up ions, the lack of the magnetic field observation prevents us from directly deriving the electric field from MEX measurements. To overcome this disadvantage, we developed a semi-automated method to estimate the IMF orientation from MEX ion data using the ring-like velocity distribution of picked-up protons of the exospheric origin. The gyration plane of these ions in velocity space is expected to be perpendicular to the IMF direction [*Yamauchi et al.*, 2006, 2008]. For the definition of the polarity of IMF, we investigated the difference of ring-ion velocity distributions between toward/away IMF configurations using the simple statistical trajectory tracing.

To validate the semi-automated method to estimate the IMF orientation from the ring-ion distributions, we first applied it to ring-ion signatures observed by Venus Express (VEX) ion data, which allow us to compare with the magnetometer data on board. Then we used it to study the effects of the solar wind electric field direction on the heavy-ion precipitations on statistical basis for Mars.

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