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MGS 探査機により観測された火星 400km 高度への太陽風侵入の非対称性
Asymmetric penetration of solar wind perturbations down to 400-km altitudes at Mars observed by Mars Global Surveyor

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Since Mars has no intrinsic global magnetic field, the solar wind can directly interact with the Martian upper atmosphere. It is thought that solar wind encountering Mars can penetrate into the point where the solar wind dynamic pressure and the plasma thermal pressure in the Martian ionosphere are almost balanced and the shocked solar wind flow is deflected around the boundary. However, the actual interaction can be complicated because of the plasma processes and the existence of crustal magnetic fields. It has been also pointed out that the crustal magnetic fields can locally push the boundary between the solar wind and the Martian magnetic pileup region (MPB ; magnetic pileup boundary) upward and cause the asymmetric structure of MPB. [e.g., Brain et al., 2003] The Kelvin-Helmholtz (K-H) instability at the Martian ionopause is one of important candidate processes to cause the modification of the asymmetric structure of the ionopause. In the plane perpendicular to the interplanetary magnetic field (IMF), the convection flow in the induced magnetosphere due to the draped field around the planet causes the asymmetry of the radial electric field direction, i.e., the hemispheres of the upward and downward convection electric fields. In the hemispheres of the upward solar wind convection electric fields, the wavy structures at the ionopause surface generated by the K-H instability tend to be enhanced. This enhancement may make the shocked solar wind (magnetosheath) plasma penetrate into lower altitudes than usual [e.g., Terada et al., 2002]. The Mars Global Surveyor (MGS) observations showed that MPB typically located at 800˜1200km altitudes in dayside. However, this boundary location can change significantly depending on solar wind conditions. While previous studies indicate that the solar wind can penetrate into lower altitudes than usual when the solar wind pressure is high [Brain et al., 2005], the frequency of the solar wind penetration and its quantitative dependence on the solar wind conditions are not yet well understood. In this study, we focused on penetration of the magnetosheath, down to 400-km altitude at Mars. Using MGS data, we investigated the observational frequency and characteristics of the penetration events. We used data from the MGS mapping orbits from April 1999 to November 2006, while the spacecraft was in a nearly circular orbit at ˜400 km altitudes. The mapping orbit is a polar orbit fixed in the local time at 2 am/pm, and the spacecraft orbital period is roughly two hours. When MGS passed through the magnetosheath-like region, fluctuations of the magnetic field and the high-energy electron flux were increased [e.g., Crider et al., 2005]. We first selected the time intervals when the power spectral density of the magnetic field fluctuation above 0.1Hz was higher than 1000 nT^2/Hz, and the differential electron flux above 400eV was greater than $5*10^4/(cm^2*s*sr*eV)$. Then, we eliminated inappropriate events such as the plasma sheet crossings by inspection. We identified 218 events for the period of interest. The dependence on the solar wind dynamic pressure around Mars, the polarity of IMF, and the motional electric field around Mars are investigated. We use both the solar wind proxy data by Brain et al. [2006] and the time-shifted ACE data. The results show that the penetration events tend to be observed during high solar wind dynamic pressure period. The ACE data indicated that, the occurrence frequency of the away polarity of IMF is alsmost comparable to that of the toward polarity. However, it was found that the penetration events tend to be observed during the away polarity of IMF in the northern hemisphere of Mars. This condition corresponds to the frequent observations in the upward electric field hemisphere and consistent with the asymmetric structure of MPB by the enhanced wavy structures at the ionopause generated by the finite Larmor radius effects in the K-H instability.

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