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Protons precipitation onto the Martian atmosphere: Mars Express observations

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Abstract

For the first time, an investigation of the solar wind protons precipitation onto the Martian atmosphere has been performed. Using data from the ion mass analyser IMA of the ASPERA-3 instrument (described in [1]) on board the Mars Express mission, we studied two orbits where the precipitation occurred. On February 27, 2004, high energy H^+ flux (from 2 up to 7 keV) were observed near the pericenter at ~ 270 km altitude, as reported in [2]. On March 1, 2004, H^+ in an energy range of 2-2.5 keV were measured at ~ 487 km altitude. In both case the events were reported on the dayside close to the subsolar point. Mars Global Surveyor (MGS) showed that the strong magnetic anomalies in the southern hemisphere may shield the Martian atmosphere from solar wind access [3]. However, magnetosheath electrons may still reach low altitudes, entering through the magnetic cusps. We thus investigated the influence of the magnetic anomalies on the proton precipitation events. The crustal field calculated with the Cain model [4] at the position of Mars Express showed that for the event on February 27, 2004, the protons intrusion happened in a cusp of a weak anomaly and on March 1, 2004, the precipitation event happened in a region of very weak magnetic field. We calculated protons velocity direction, and showed that a part of the observed H^+ indeed precipitated, for both orbits. We have also investigated solar wind conditions for both orbits. On February 27, 2004, unfortunately, there was no solar wind data available and we used a proxy of the solar wind upstream pressure calculated from the MGS measurements at a 400 km-orbit, ([5]). The event occurred during a low dynamical pressure period (around 1 nPa). On March 1, 2004, the solar wind data were available and indicated an average bulk velocity of 400 km/s. So even the quiet solar wind would be able to access the Martian atmosphere. Finally, on February 27, 2004, the energy spectra of the precipitating H^+ seem quite different from each other but some presented clearly an energy peak around 2 keV or around 5 keV depending on the time. On March 1, 2004, the energy spectra of the precipitating H^+ showed a peak in energy around 2 keV and agreed qualitatively with the spectra of precipitating H^+ from the 3D hybrid model from [6]. The proton precipitation is a kinetic effect due to a small size of the Martian magnetosheath with respect to the proton gyroradius. The large gyroradius of the energetic protons (more than 1 keV) present in the hot, few hundred eV plasma in the subsolar magnetosheath allows them to penetrate the magnetic barrier and reach the atmosphere, above the regions where the magnetic anomalies are weak (less than ~ 50 nT) and/or cusp-like.

References

[1] Barabash, S. et al. (2006) *Space Science Reviews*, 126, 1-4, 113–164.

[2] Lundin, R. et al. (2004) *Science*, 305, 5692, 1933-1936.

[3] Acuña, M. (1998) *Science*, 279, 5357, 1676-1680.

[4] Cain, J. et al. (2003) *JGR*, 108, E2, 2-1.

[5] Crider, D. et al. (2003) *JGR*, 108, A12, 1461.

[6] Brecht, S. (1997) *JGR*, 102, A6, 11287-11294.