Geophysical Research Abstracts
Vol. 15, EGU2013-4084, 2013
EGU General Assembly 2013

Cold Ion Escape from the Martian Ionosphere

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It has always been challenging to observe the flux of ions with energies of less than 10eV escaping from the planetary ionospheres. We here report on new measurements of the ionospheric ion flows at Mars by the ASPERA-3 experiment on board Mars Express. We first use support from the MARSIS radar experiment for some orbits with fortunate observation geometry. Here we have observed a transterminator flow of O^+ and O_2^+ ions with a supersonic velocity of around 5km/s and fluxes of $0.8 \cdot 10^9$/cm^{2}s. If we assume a symmetric flux around the terminator this corresponds to an ion flow of $3.1 \pm 0.5 \times 10^{25}/s$ half of which is expected to escape from Mars (Fraenz et al, Plan.Space Sci., 2010). This escape flux is significantly higher than previously observed on the tailside of Mars, we discuss possible reasons for the difference. Since 2008 the MARSIS radar does nightside local plasma density measurements which often coincide with ASPERA-3 measurements. In a new analysis of the combined nightside datasets we show that the main escape channel is along the shadow boundary on the tailside of Mars. At a distance of half a Martian radius the flux settles at a constant value which indicates that about half of the transterminator ionospheric flow escapes from the planet.

Possible mechanism to generate this flux can be the ionospheric pressure gradient between dayside and nightside or momentum transfer from the solar wind via the induced magnetic field since the flow velocity is in the Alfvénic regime.