Geophysical Research Abstracts, Vol. 9, 06107, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06107

The magnetic Effect of atmospheric Escape at Mars

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The direct loss of planetary ions accelerated by the solar wind electric field of convection is thought to be among the most important escape mechanism acting on the Martian atmosphere. This is particularly true in the early phases of the planetary evolution, where both the solar EUV flux and the solar wind are believed to have been much stronger than today. In order to estimate the past escape rates it is therefore extremely important to establish the solar dependence of the escape. However, little is known about the dynamics of the pick-up process, and quantitative estimates of the effect of the varying solar wind is still lacking.

Theoretical modeling of solar wind - Mars interactions predict that the process of solar wind pick-up of planetary ions results in a strong hemispherical asymmetry of both plasma and magnetic field parameters near Mars. The asymmetry, which has been confirmed observationally, is controlled by the direction of the solar wind convective electric field. The solar dependence of the pick-up is difficult to obtain directly from in situ particle measurements, because of the large spatial and temporal variations in the particle fluxes. The magnetic asymmetry, on the other hand, constitutes an integrated effect, and may thus provide a global measure of the large scale current structure associated with the process. Quantitative estimates of the magnetic asymmetry may be used to constrain theoretical models, and thus may indirectly be used to estimate the global flux of escaping pick-up ions. We study the asymmetry by comparing magnetic observations from the Mars Global Surveyor in the magnetic pile-up region with the results of a hybrid model of solar wind Mars interactions.

Combined magnetic field and plasma observations near Mars together with upstream monitoring of the solar wind, as proposed in the Mars Escape and Magnetic Orbiter (MEMO), is clearly needed. Similarly, simultaneous magnetic field observations from

the surface and from orbit, would be very valuable.