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Solar wind precipitation on Mars

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Abstract

We have found that solar wind particles frequently precipitate onto the atmosphere of Mars [1,2]. The precipitating particles contribute to the energy and matter flux into the ionosphere. We use ion data from the ASPERA-3 instrument onboard Mars Express to investigate the precipitation patterns, processes and the total transfer of energy and matter from the solar wind to the atmosphere. The main reason for the proton and alpha particle precipitation is likely the large gyroradii of hot particles compared to the size of the induced magnetosphere/magnetic barrier. We find that the particle penetration depends on the direction of the convection electric field in the solar wind but that the crustal magnetic fields have very little influence. The total energy flux is low compared to the solar radiation heating on the dayside, but a significant energy source on the night-side. We also believe that the solar wind alpha-particles precipitating into the atmosphere is an important source of the neutral helium in the Martian atmosphere.

We combine our observations with computer modeling [3,4]. We have applied a Direct Simulation Monte Carlo method to solve the kinetic equation for the H/H^+ transport in the upper Martian atmosphere including CO_2, N_2 and O. We conclude that the induced magnetic field around Mars plays the crucial role in the transport of charged particles in the upper atmosphere, and it determines the energy deposition of the solar wind.

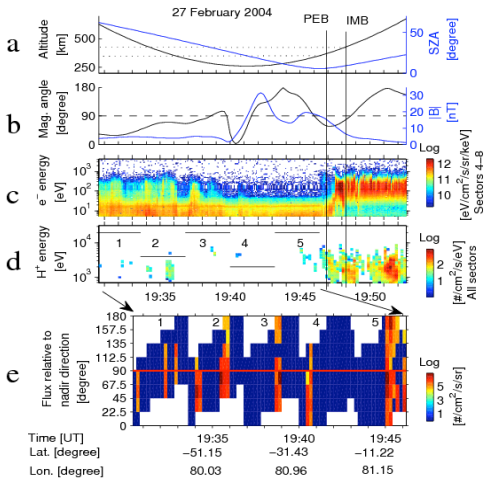

Figure 1: Example of a proton precipitation event. Panel (a) shows the altitude and SZA of Mars Express, panel (b) presents the magnitude of the magnetic field and the angle of the magnetic field vector relative to the local (Cain model), panel (c) is the energy-time spectrum of electrons, panel (d) the energy-time spectrogram of protons averaged over all sectors and panel (e) shows the proton flux direction relative to nadir.

References

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