A Model Analysis of the Observed Topside Plasma Scale Heights at Mars

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The altitude profiles of the Martian ionosphere have been measured extensively for a period of several years by the Mars Global Surveyor (MGS) and Mars Express (MEX) orbiters. These profiles have been interpreted by our modified version of a one-dimensional, multi-species chemical diffusive model. This interpretation explored new insights into the chemical and dynamical processes that take place in the upper atmosphere of Mars. In a planetary ionosphere, the magnetic field plays an important role in the process of plasma transport. The MGS magnetometer observations of Mars provided no evidence of a significant planetary magnetic field at Mars. However, the observations of the top-side plasma scale heights indicate quite variable topside ionospheric structure, which seems to violate diffusive equilibrium: the condition that would have been imposed by a magnetic field-free ionosphere. Such a behavior of the ionosphere could be interpreted as due to an external magnetic field arising from solar wind interaction with the Martian ionospheric/atmospheric system. For the case of a purely induced horizontal field, the plasma loss is due to both the downward flow and horizontal divergence of ion velocities. However, for the case of a vertical magnetic field, an upward flow of plasma seems to play an important role in the upper ionosphere. The vertical transport of plasma in our modified version of the model is simulated by vertical ion velocities, whose values can be interpreted as drift velocities of vertical flow of plasma. The magnitudes of these velocities are compared with the plasma velocities simulated by existing 3-D multi-species MHD models. The model results from the analysis of MGS and ME observations will be discussed.