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A time-dependent ionospheric model of Mars: Analysis of MGS-RSS electron density profiles

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Radio occultation experiments onboard the Mars Global Surveyor (MGS) measured the vertical structure of Marian ionosphere for a period of almost five years. So far, only four electron density (Ne) datasets have been released for model analysis by the radio occultation team. Each dataset hosts a suite of more than 28 Ne profiles for the high latitude regions. These profiles have been interpreted by our modified version of a one-dimensional, multi-species MHD model originally developed by Shinagawa and Cravens [1988]. This interpretation explored new insights into the chemical and dynamical processes that take place in the upper atmosphere of Mars. Note that the magnetic field plays an important role in the process of plasma transport in a planetary ionosphere. The MGS-magnetometer observations of Mars provided no evidence of a significant planetary magnetic field at Mars. However, the observations of the topside 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 the solar wind interaction with the Martian ionospheric/atmosphere system. Although the orientation of the induced field is not known, it could be either horizontal or vertical. 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 December 1998 and May 1999 observations will be discussed.