Crustal magnetic field effects on the high-latitude electron density profiles at Mars

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The measurements of the Martian high-latitude ionosphere by the Mars Express Radio Science Experiments near terminators have shown complex range of features for the plasma transport region. The measured dayside electron density profiles for large SZAs have shown unprecedented characteristics of the topside plasma distribution with scale heights in the range from tens of kilometers to hundreds of kilometers. The measured height of the top of the ionosphere ranges from 300 km to more than 600 km. Most recently, MAVEN has also measured in situ density profiles of the Martian ionospheric ions from its periapsis altitude of ~130 km to an altitude of about 500 km. Some of the topside electron density profiles indicate strong solar wind interaction with the upper ionosphere and a variable magnetic field environment. The variation of the measured topside plasma scale heights seems to violate diffusive equilibrium: the condition that would have been imposed by a magnetic field-free ionosphere. Such a behavior of the ionosphere can be interpreted by the vertical plasma transport caused by the interaction between the solar wind and crustal magnetic field lines. The vertical transport of plasma in our 1-D chemical diffusive model is simulated by vertical ion velocities, whose values can be interpreted as drift velocities along the magnetic field lines. We find that the variation of the model electron density scale heights is sensitive to the magnitudes of upward and downward drifts. We also find that a combination of upward and downward drifts in the range 6 m/s to 35 m/s is required to explain some of the measured topside electron density profiles in the vicinity of strong crustal magnetic field. The magnitudes of these drift velocities are compared with the plasma velocities simulated by existing models. The model results will be presented in comparison with the measured electron density as well as ion density profiles. We acknowledge support for this work from the Mohammed Bin Rashid Space Center (MBRSC), Dubai, UAE.

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