ION DRIFTS IN THE UPPER IONOSPHERE OF MARS. T. Majeed[1], S. W. Bougher[2], P. Withers[3] and S. A. Haider[4], [1]Department of Physics, American University of Sharjah, UAE, [2]Climate and Space Sciences and Engineering Department, University of Michigan, Ann Arbor, Michigan, USA, [3]Department of Astronomy, Boston University, Boston, MA, USA, [4]Space and Atmospheric Sciences, Physical Research Laboratory, Ahmedabad, India .

Introduction: The electron density (N_e) data acquired over the southern high-latitude region by the Radio Occultation Science Experiment (ROSE) onboard the Mars Atmosphere and Volatile Evolution (MAVEN) have shown more complicated ionospheric structure of Mars than previously thought. The data have shown the topside plasma distribution with unusually large N_e scale heights presumably in response to downward accelerating solar wind electrons along magnetic field lines. Our focus in this paper is to use our 1-D chemical diffusive model coupled with the Mars - Global Ionosphere Thermosphere Model (M-GITM) to quantify the physical processes necessary to interpret the dayside N_e measurements over regions where the crustal magnetic field lines are nearly vertical and open to the access of solar wind plasma through magnetic reconnection with the interplanetary magnetic field. This can lead to the acceleration of electrons and ions during the daytime ionosphere. The downward accelerated electrons with energies >200 eV penetrate deep into the Martian upper ionosphere along vertical magnetic field lines and cause heating, excitation, and ionization of the background atmosphere. The upward acceleration of ions resulting from energy input by precipitating electrons can lead to enhance ion escape rate and modify scale heights of the topside ionosphere.

Model: Our model is a coupled finite difference primitive equation model which solves for plasma densities and vertical ion fluxes. The model assumes photochemical equilibrium for each ion at lower boundary (100 km altitude), while a fixed velocity boundary condition is assumed at upper boundary (400 km altitude) to simulate plasma loss from the Martian ionosphere. While the primary source of ionization in the model is due to solar EUV radiation, an extra ionization source due to precipitating electrons of 0.25 keV, peaking near an altitude of 145 km is added in the model.

Results: We find that the photochemical control of the Martian ionosphere is ended at the height well above the ionospheric peak. To interpret the measured ionospheric structure at altitudes where plasma transport dominates, we find it is necessary to impose field-aligned vertical plasma drifts caused by the motion of neutral winds. The most interesting finding of this study is that both upward (between 30 ms^{-1} and 70 ms^{-1}) and downward (between -12 ms^{-1} and -9 ms^{-1}) drifts are required to maintain the topside N_e distribution comparable with the measured N_e distribution. We also find that a fixed velocity boundary condition at the upper boundary with a sizeable upward ion velocity is needed to encounter any unexpected ion accumulation in the topside ionosphere to limit the Martian ion outflow. The corresponding outward fluxes in the range $7 \times 10^6 - 3 \times 10^7$ $cm^{-2} s^{-1}$ are calculated for O_2^+ compared to those for O^+ in the range $4 \times 10^6 - 7 \times 10^6$ $cm^{-2} s^{-1}$. The impact of vertical drifts on the plasma transport is gradually weakened in the region below the transition height (the height between photochemistry and transport) as the thermospheric winds slowed down. The Martian ionosphere in this region is found to be in photochemical equilibrium to maintain the model densities close to the measured densities. Given the complex nature of neutral dynamics and its relationship to plasma transport processes over magnetic anomalies, we consider that a simple model, such as we have developed, is still capable of yielding valuable insights relating to the neutral wind system at Mars. The model results will be presented in comparison with N_e measurements. A discussion is also presented on estimates of ion escape rates from the upper ionosphere of Mars.

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