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A Model Analysis of the MAVEN/ROSE Electron Density Profiles at Mars

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The electron density (N_e) profiles over the northern high-latitude region measured with Radio Occultation Science Experiments (ROSE) onboard the Mars Atmosphere and Volatile Evolution (MAVEN) have indicated more complicated ionospheric structure of Mars than previously thought. Some of the profiles have shown wide and narrow shapes of the main N_e peaks, while others show anomalous characteristics of the topside plasma distribution. Large variations in the topside N_e scale heights are observed presumably in response to the outward flow of ionospheric plasma or changes in plasma temperatures. We use our 1-D chemical diffusive model coupled with the Mars - Global Ionosphere Thermosphere Model (M-GITM) to interpret these N_e profiles. Our model is a coupled finite difference primitive equation model which solves for plasma densities and vertical ion fluxes. The photochemical equilibrium in the model for each ion is assumed at the lower boundary, while the flux boundary condition is assumed at the upper boundary to simulate plasma loss from the Martian ionosphere. The crustal magnetic field at the measured N_e locations is weak and mainly horizontal and does not allow plasma to move vertically. Thus, the primary plasma loss from the topside ionosphere at these locations is most likely caused by diverging horizontal fluxes of ions, indicating that the dynamics of the upper ionosphere of Mars is controlled by the solar wind. The primary source of ionization in the model is due to solar EUV radiation. We find that the variation in the topside N_e scale heights is sensitive to magnitudes of upward ion fluxes derived from ion velocities that we impose at the upper boundary to explain the topside ionospheric structure. The model requires upward velocities ranging from 60 ms^{-1} to 80 ms^{-1} for all ions to ensure an agreement with the measured N_e profiles. The corresponding outward fluxes in the range 1.6 x 10^6 – 3.8 x 10^6 cm^{-2} s^{-1} are calculated for O_2^+ compared to those for O^+ in the range 4 x 105 – 6 x 105 cm^{-2} s^{-1}. The model results for the northern N_e profiles will be presented in comparison with the measured N_e profiles. This work is supported by Mohammed Bin Rashid Space Centre (MBRSC), Dubai, UAE, under Grant ID number 201604.MA.AUS.