A Model Analysis of the Northern High-latitude Ionosphere of Mars

*Omar Al Aryani[1], Tariq Majeed[1], Shahd Al Mutawa[1], Mohammed Al Qasimi[1], Steve S Bougher[2], Syed A Haider[3]

1. American University of Sharjah, 2. University of Michigan, Ann Arbor, USA, 3. Physical Research Laboratory, Ahmedabad, India

The measurements of the vertical electron density profiles by the Mars Express Radio Science Experiments near the Martian terminators have indicated more complicated structure of the northern high-latitude ionosphere than previously thought. The measurements show wide and narrow shapes of the main ionospheric peaks with variable scale heights of the topside ionosphere at locations where the strength of the crustal magnetic field was weak and mainly horizontal. This unusual behavior of the measured ionosphere in the northern hemisphere cannot be interpreted by simple ionospheric models. In regions of weak crustal fields, solar-wind induced field has draped morphology and does not allow plasma to move vertically. For the induced field to restrict the vertical plasma motion, it must be predominantly horizontal. The primary plasma loss for the topside ionosphere in these regions is likely caused by diverging horizontal fluxes of ions, indicating that the dynamics of the upper ionosphere of Mars is controlled by the solar wind. We use our 1-D chemical diffusive model to interpret the measured electron density profiles at several locations in the northern hemisphere. Our model is a coupled finite difference primitive equation model which solves for plasma densities and vertical ion fluxes. The coupled model uses a model of the thermospheric temperature and composition from the Mars - Global Ionosphere Thermosphere Model (M-GITM). The model assumes photochemical equilibrium condition for each ion at lower boundary, while flux boundary condition is assumed at upper boundary to simulate divergence of the horizontal ion fluxes. We find that the upward flux in the range 5×10^6 cm^{-2} s^{-1} to 5×10^7 cm^{-2} s^{-1} is required to explain the measured topside electron density profiles, while photochemical equilibrium prevails near and below the ionospheric peak. We will present the model results in comparison with measurements. We will also discuss estimates of ion escape from the upper ionosphere of Mars. We acknowledge support for this work from the Mohammed Bin Rashid Space Center (MBRSC), Dubai, UAE.

Keywords: Mars, Northern, Crustal

