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Ionospheric Seasonal Variation in Martian Equatorial Region

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Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) is a multi-frequency, synthetic-aperture, orbital sounding radar onboard Mars Express which was launched into an elliptic orbit with an inclination of 86.35 deg on 25 Nov 2003. By analyzing the surface echoes of MARSIS, Safaeinili proposed a method to calibrate the ionospheric effect and estimate the total electron content (TEC), peak electron density and neutral atmosphere scale height near the ionospheric peak properly. Using this method to collect TEC of Martian ionosphere over one Martian year from MARSIS, we have found TEC of ionosphere in Martian Equatorial Region is seasonal changed, and the changing trend is correlated with the seasonal cycle of carbon dioxide. As we know, in the lower ionosphere, photoelectron ionization is significant and makes a contribution of 20˜30% to the total ionization rate [Nier and McElroy, 1977]. Even though CO_2 is the major atmospheric constituent of Mars at low altitudes and CO_2^+ ions are the primary ions produced below 100 km, O_2^+ ions are dominant at low altitudes (<260 km) because most of the CO_2^+ ions are broken down into O_2^+ ions through a subsequent ion-neutral reaction ($CO_2^+ + O \rightarrow O_2^+ + CO$). In a word, CO_2 is vaporized from polar cap, then photo-ionized to be CO_2^+, O_2^+ etc. These charged particles are main ions of Martian ionosphere, and interact with solar wind directly. As solar wind flows past Mars, significant amounts of ions are taken away. It means that oxygen dissociated from CO_2 escape from Martian atmosphere. Based on MARSIS TEC data, the amplitude of TEC changing is about 10^2 per m^2 which affects the oxygen escape speed.

Keywords: Mars, TEC, Carbon Dioxide