Ionospheric Seasonal Variation in Martian Equatorial Region. M. Wang[1], T. Kobayashi[1] and J. Ping[1], [1]Shanghai Astronomica Observatory, CAS, Nandan Road 80, Shanghai, China, 200030. (email: mywang@shao.ac.cn).

Introduction: 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 on 25 Nov 2003[3]. 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[1,2]. Using this method to collect TEC of Martian ionosphere over one Martian year from MARSIS, we have found seasonal change of the ionosphere in Martian Equatorial Region. This seasonal change is correlated with the seasonal cycle of carbon dioxide which is exchanged between polar cap and atmosphere.

Data Analysis: In this study we use the total electron densities inferred from the MARSIS subsurface measurements. During its working period, MARSIS provides subsurface measurement, which is used to deduce Martian ionospheric local total electron content (TEC) and its global distribution with resolution of about 0.1 deg in latitude (~5 km footprint) [1]. Over 335209 independent measurement of the TEC result in equation region of MARSIS observed from 19 June 2005 to 30 September 2007 are used in this study.

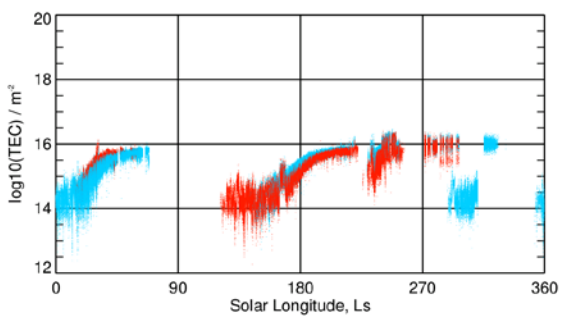

Fig. 1. Seasonal variation of TEC in Martian equatorial region. The latitude range of data is 25N~25S. The red dot is from north hemisphere and the blue one from south hemisphere.

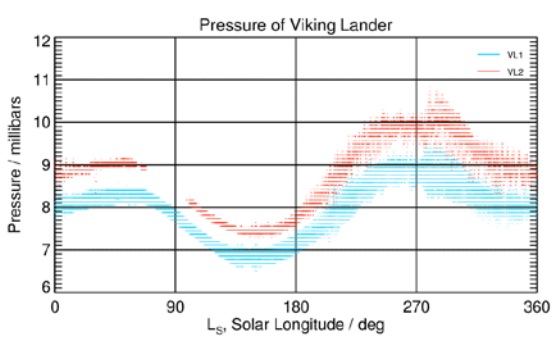

Fig. 2. Latitudinal profiles of atmosphere pressure during Viking Lander missions. Pressure measured by Viking Lander 1 is shown in blue dot; pressure of Viking Lander 2 is shown in red dot. The position of Viking Lander 1 is 22.48°N, 49.97°W; the position of Viking Lander 1is 47.97° N, 225.74° W.

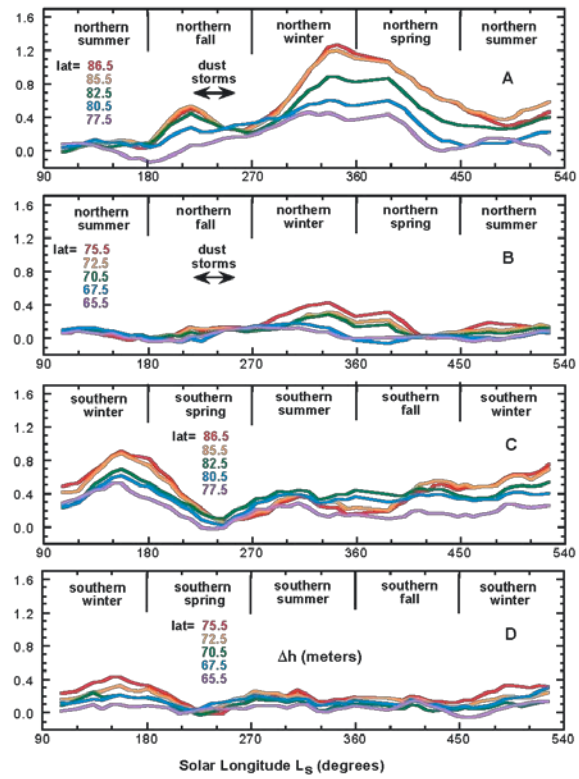

Fig. 3[4]. Latitudinal profiles of elevation change (Δh) over the course of the MGS mapping mission and martian seasons (solar longitude L_s) in the (A) north polar, (B) north mid-latitude, (C) south polar, and (D) south mid-latitude regions. Shown in (A) and (B) is the time of regional dust storms that warmed the atmosphere and caused off-season sublimation in the northern hemisphere. Elevation changes in the northern hemisphere are with respect to latitude 60° N and those in the southern hemisphere are with respect to 60° S.

In figure 1, it is shown seasonal variation of TEC in Martian equatorial region. Clearly the maxium of TEC appeared at northern winter solstice (L_s=270°) and the second peak appeared at about southern winter solstice

(L_s~90°). Normally the minium of TEC appeared at northern spring equinox and sourthern spring equinox. Compared to fig.2, the trend of TEC and pressure of Martian atmosphere is synchronous. Scince the seasonal condensation flux between two polar caps course the annual change of atmosphere pressure. In fig. 2, the highest value of atmosphere pressure appeared at northern winter solstice (L_s=270°) and the lowest value appeared at the end of northern summar (L_s~180°).

In fig. 3, when L_s is about 180° , the north hemisphere is in autumnal equinox and the north pole cap is thinnest in the whole Martian year. It is also clear that the south pole cap is thickest in the whole Martian year. It means the carbon dioxide had sublimated from North Pole and finish the migration from north pole to south pole. When L_s is about 360° , the process is opposite. At these time the carbon dioxide staied in polar cap and the pressure of atmosphere is low. It means the density of carbon dioxide in atmosphere is low. So that TEC is low. From L_s ~0° to 180° and from L_s ~180° to 360° , the process of carbon dioxide migration is ongoing.

Discussion: MARSIS subsurface observations have shown the annual cycle of carbon dioxide between Martian north pole cap and Martian south pole cap cause the carbon dioxide density changing in atmosphere. Since the main material of Martian ionization is carbon dioxide, the annual cycle of carbon dioxide cause the seasonal changing of TEC in Martian ionosphere. The amplitude of TEC changing is about 10^2 per m^2 . The trends of pole cap thickness, carbon dioxide density in atmopshere and TEC in Martian ionosphere are synchronous.

References: [1] Safaeinili A., Kofman W., Mouginot J., Gim Y., Herique A., Ivanov A. B., Plaut J. J. and Picardi G. (2007), Geophys. Res. Lett., 34, L23204. [2] Safaeinili A., Kofman W., Nouvel J-F, Herique A. and Jorden R. L. (2003) Planet. Space Sci., 51, 505-515. [3] Nielsen E. (2004) Space Sci. Rev., 111, 245-262. [4] Smith D. E., Zuber M. T. and Neumann G. A. (2001) Science, 294, 2141.