R009-32
Zoom meeting D ：11/2 AM2 (10:45-12:30)
12:00-12:15

Seasonal variation of dayside ionospheric compositions coupled with neutral upper atmosphere on Mars

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The Martian thermosphere-ionosphere is a source for atmospheric escape, which is affected by both the lower-middle atmosphere and external forces. Escape rates of planetary ions from Mars change responding to the change in the solar wind and solar EUV radiation (e.g., Lundin et al., 2008a; Dubinin et al., 2017a; Dong et al., 2017), although a connection between the compositions of escape ions and ionospheric ions is an open question. Besides, recent studies suggest an impact of the lower-middle atmospheric variability on the upper atmosphere. Jakosky et al. (2017) and Slipski et al. (2018) showed a substantial variation of the homopause altitude on Mars. In addition, Yoshida et al. (under review) suggested that variations of dayside homopause altitude and N_2/CO_2 at 140 km altitude are mainly controlled by inflation and contraction of the lower atmosphere due to a change in solar heating with the Sun-Mars distance. N_2/CO_2 at 140 km varies in the range of 0.02 and 0.20, which is associated with the variations of homopause altitude. The change of atmospheric composition in the lower thermosphere would affect ionospheric composition because they are coupled with each other through photochemistry. In this study, we aim to investigate the coupling of atmospheric composition in the thermosphere and ionosphere by in-situ observations.
Seasonal variations of atmospheric compositions in the dayside thermosphere and ionosphere have been investigated using data from December 2014 to March 2018 obtained by Neutral Gas and Ion Mass Spectrometer (NGIMS) on Mars Atmosphere and Volatile EvolutioN (MAVEN). In the thermosphere, densities of CO_2, N_2, and O show seasonal sinusoidal variations. Higher values appear during perihelion and lower values during aphelion. CO_2 at 200 km altitude varies in the range from 3.36(10^6) to 1.74(10^8) cm^{-3}. This can be explained by inflation and contraction of the lower atmosphere (Yoshida et al., under review). In the ionosphere, the seasonal sinusoidal trend is also found in the CO_2^+ number density, associated with the variation of neutral CO_2 in the thermosphere. On the other hand, N^+ density shows the opposite sinusoidal trend to CO_2^+. This can be explained by the loss process of N^+, which reacts with CO_2 by the charge exchange. The vertical structures of ion species between 150 and 250 km altitude show a clear seasonal variation in the whole altitude range for CO_2^+ and O_2^+. However, it is noteworthy that the seasonal variation of vertical profiles of O^+ is not obvious. Under the photochemical equilibrium of the ionospheric layer below ~200 km, we have evaluated our results discussed above. We find that the significant variation of CO_2 associated with atmospheric inflation and contraction can explain the seasonal variations of ionospheric species, CO_2^+, O_2^+, and O^+. On the other hand, our result also shows a strong depletion of O_2^+ and O^+ between 150 and 250 km altitude during a dust storm event (Ls ~300 in MY 33). Our result reveals that different behavior of ionospheric species during the dust storm can be explained by a significant decrease of neutral O density in the thermosphere during the dust season.