R009-34
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14:00-14:15

Molecular Ion Contribution to the Polar Plume from Mars and its Dependence on Solar Wind Parameters

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Mars once had water on its surface about 4 billion years ago, but there is no liquid water on the surface at present. Escape of the atmosphere to space is considered as the main cause of this climate change. However, the mechanism of the large amount of atmospheric loss is far from understood. Ion escape is one of the important candidates of the loss mechanism. There are three channels of the ion escape, namely, tailward escape, pickup ion, and polar plume. Polar plume ions are accelerated by the solar wind convection electric field and escape to positive E hemisphere of the Mars-Sun-Electric field (MSE) coordinates. It is estimated by Dong et al. (2017) that the escape rate of O^+ plume is 20-30% of the total O^+ escape depending on the solar EUV radiation. The rate is not negligible in order to understand the ion loss from Mars. Molecular ions in the polar plume should also be studied since it is shown that main escape species is O_2^+ for tailward escape by Inui et al. (2019). We recently reported a CO_2^+-rich plume event on August 28, 2015. Peak flux of CO_2^+ was $4.2x10^6$ $cm^{-2}s^{-1}$, which is about one order of magnitude higher than the average flux of O^+ in the polar plume reported by Dong et al. (2017). Such high escape flux is unexpected because CO_2^+ is a minor component at high-altitude ionosphere due to its small scale height. To fully understand the mechanism of the polar plume, it is important to study the composition of the polar plumes.
In order to investigate relationship between a CO_2^+-rich plume event and solar wind (SW) conditions, we conducted a statistical study. We analyzed data obtained by STATIC (Supra Thermal and Thermal Ion Composition), MAG (magnetometer) and SWIA (Solar Wind Ion Analyzer) onboard MAVEN (Mars Atmosphere and Volatile EvolutioN) from Nov. 28, 2014 to Oct. 11, 2019. STATIC measures ion distribution functions with mass discrimination. In order to derive CO_2^+ number density, we use the fitting method invented by Inui et al. (2018). By fitting a log-normal distribution to O_2^+ count data, we remove O_2^+ contamination in the CO_2^+ mass range.
The results show that CO_2^+ plume events tend to be observed under high solar wind dynamic pressure and strong electric field conditions. This result is consistent with hypothesis that CO_2^+ plume is caused by deep penetration of the solar wind convection electric field due to the high solar wind dynamic pressure. On the other hand, observation frequency of O_2^+ plume events does not show such dependences on the solar wind parameters. This is probably because O_2^+ is abundant near the ionopause enough to create O_2^+ plumes regardless of the solar wind conditions. The results also show that correlations between the escape flux of CO_2^+ plume and solar wind parameters is weak. One possible reason of this weak correlation is the large orbit-to-orbit flux variation depending on whether MAVEN passes “hot spot" of the plume or not. In order to assess this hypothesis, we will report the results of statistical trajectory tracings in MHD fields obtained under different solar wind conditions.
References
Dong, Y., et al. (2017), J. Geophys. Res. Space Phys., 122, 4009?4022, doi:10.1002/2016JA023517
Inui, S., et al. (2018), Geophys. Res. Lett., 45, 5283?5289, doi:10.1029/2018GL077584
Inui, S., et al. (2019). J. Geophys. Res. Space Phys., 124, 5482?5497. doi:10.1029/2018JA026452