Effects of dust storms on ion density variation in the Martian ionosphere based on long-term MAVEN/STATIC observations

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Mars is currently covered by a thin atmosphere, and dust storms is an important phenomenon to understand vertical coupling of Martian atmosphere and resultant neutral hydrogen escape to space [e.g., Chaffin et al., 2021]. Withers et al. (2019) showed that variations in the ionospheric ion densities are affected by the crustal magnetic field of Mars. In addition, dust storms of various scales occur on the Martian surface, and in particular global dust storms have been shown to affect the composition of the exosphere (Liu et al., 2018, Girazian et al., 2019). However, the impact of dust storms on ionospheric ion composition is still far from understood. In this study, we investigated variation of the ion composition in the Martian ionosphere based on observations by the STATIC instrument onboard MAVEN with a focus on effects of the dust storms.
In the statistical analysis, MAVEN data from January 2017 to December 2020, which approximately covers 2 Martian years, are used. We focused on the dayside ionosphere with altitudes from 225 km to 300 km. The density variations of major ion species including H^+, O^+, O_2^+, and CO_2^+ in the Martian ionosphere were investigated. In order to select ionospheric observations and assure the quality of data, the following criteria of data selection were applied. STATIC is operated under conic mode and its attenuator state is appropriate for dayside ionospheric observations (2 and 3). The spacecraft RAM direction is within 10 degrees from the center of the STATIC’ s field of view. The O_2^+ density is 10 times larger than H+ density. The results show that the molecular ion densities, e.g., O_2^+ and CO_2^+, are enhanced in the vicinity of the Martian crustal magnetic fields regardless of the Martian season, while the tendency is less clear for O+. This tendency is consistent with the results of Withers et al. (2019). We also found that the densities of H^+, O_2^+, and CO_2^+ increased globally during the dust season with a solar longitude between 180 and 360 degrees, while the dependence on the dust season is not obvious for O^+ in this altitude range. In the presentation, we will also discuss the physical mechanisms responsible for variation of the ionospheric composition in the Martian ionosphere.

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