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Time Variation of the Nonthermal Escape of Oxygen from Mars: A Two-Stream Model Coupled with an MHD Ionosphere Model

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Mars has no significant intrinsic magnetic field, hence no developed magnetosphere, which indicates that the escape mechanism of the Martian atmosphere differs from that of Earth. Escape of neutrals is potentially important for the evolution of the Martian environment. McElroy et al. [1977] suggested that dissociative recombination of O_2^+, the major ion in the Martian ionosphere, was the dominating escape mechanism for oxygen. After his suggestion, a number of theoretical and quantitative calculations of nonthermal oxygen escape rates have been reported. However, all of them were restricted to the case where the ionospheric parameters were assumed to be under steady state condition. We have investigated the escape rate by combining a time-dependent ionosphere model, i.e., a two-stream model has been coupled with a one-dimensional MHD model to simultaneously calculate the variations of the hot oxygen fluxes and the ionospheric parameters.

The solar wind, which is quite variable, directly interacts with the Martian ionosphere. Time variation of the solar wind parameters is expected to result in a dynamic response of the ionosphere. For example, an enhancement of the solar wind dynamic pressure causes a downward displacement of the ionopause altitude. In such a case, molecular oxygen ions in the upper ionosphere are pushed to lower altitudes, leading to a temporal enhancement of the dissociative recombination rate around the exobase. In this paper, we will present the result of the calculations for the time variation of the nonthermal escape of oxygen due to the dissociative recombination of O_2^+ during the ionopause displacement.