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Increase of oxygen ion escape rates from Mars after solar wind dynamic pressure enhancement

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The escape of oxygen is potentially important for the evolution of volatiles and water inventories of Mars [Lammer et al., 2003]. Phobos 2 ofservations of O^+ ion pickup suggest escape rates at Mars of about 5 - 20 x 10^{24} ions/s [Lundin et al., 1990; Verigin et al., 1991]. The potential source mechanisms for the pickup oxygen ions are photoionization, charge exchange, and solar wind electron impact ionization for the upper atmosphere and hot oxygen corona above the ionopause.

We investigate a response of oxygen escape rate from Mars to time variation of ionospheric parameters by combining a time-dependent hot oxygen corona model with a time-dependent ionosphere-magnetosheath interaction model. The Martian ionosphere directly interacts with the solar wind because Mars has no global magnetosphere. The time variation of solar wind parameters leads to a dynamic response of 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 and electrons in the upper ionosphere are pushed to lower altitudes, leading to an acceleration of dissociative recombination of $O_2{}^+$ around the exobase and a short-term enhancement of the exospheric oxygen number density. In this paper, we present the calculated oxygen ion production rates above the ionopause for photoionization, charge exchange, and solar wind electron impact ionization processes after solar wind dynamic pressure enhancement.