Photochemical Escape of Oxygen at Mars constrained with MAVEN Remote Sensing: a non-thermal process operating at all low-mass planets

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The dominant loss mechanism of oxygen from Mars to space in the current epoch is thought to be photochemical escape of hot oxygen produced by dissociative recombination of O_2^+. This ion is ultimately sourced from CO_2^+, which is the primary product of photoionization in the carbon dioxide amosphere of Mars. Photochemically energized oxygen is able to escape Mars because the planet's escape energy is less than the exothermicity of the recombination reaction; at Earth-mass planets, the same process produces only a gravitationally bound hot oxygen corona. The Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft has been at Mars since November 2014, with multiple seasons suitable for the Imaging Ultraviolet Spectrograph (IUVS) instrument to observe the dayside hot oxygen corona via fluorescence of the O I 130.4 nm triplet. This dataset provides the opportunity to examine temporal variations associated with changes in the EUV photoionizing solar radiation which produces CO_2^+ and O_2^+ ions. We present results based on two seasons: Southern Summer in Mars Year 32 during the maximum of Solar Cycle 24 and Southern Spring in Mars Year 33 late in the declining phase of the same Solar Cycle. The data in both seasons contain multiple solar rotations. We compare the oxygen corona density to the measured EUV solar flux from MAVEN's Extreme Ultraviolet Monitor (EUVM) and with the resulting ionization frequencies. The result is a strong correlation between solar EUV input, observed ionization frequency, and the density of the hot oxygen corona. In addition, a new observation strategy was employed during the MY 33 season to view the Martian corona near the sub-solar point with anti-parallel lines of sight from opposing hemispheres. These observations reveal a significant hemispherical asymmetry in brightness, providing a constraint on the large scale spatial variability of the dayside oxygen corona. These observations provide information on the processes that drive photochemical escape from Mars, through which most of Mars' atmospheric mass may have been lost. The same process is sure to be active on Mars mass planets throughout the universe: we will discuss the degree to which Mars photochemical escape can be used to inform exoplanetary atmospheric loss.