Time response of the self-regulation of H and O escapes from Mars

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Atmospheric loss from the Martian upper atmosphere plays an essential role in the evolution of the surface environment of Mars. Especially, water loss through the escapes of hydrogen and oxygen is crucial to determine the habitability. It was shown by McElroy. (1972) that Jeans escape flux of H and H2 and nonthermal escape flux of O were regulated to be in the ratio of 2:1 in a converged model, which is called "self-regulation". However, it was only confirmed in the atmospheric condition of current Mars and time response of the self-regulation is not well understood.

Here we study time-dependent responses of self-regulation system on different atmospheric conditions. We use a 1D time-dependent photochemical model for various atmospheric conditions and parameters, such as atmospheric CO2 pressure, vertical temperature profile and O escape rate.

We find that timescale of the self-regulation is mainly determined by O escape flux and the CO2 pressure. The timescale is inversely proportional to O escape flux, whereas it increases nonlinearly as the CO2 pressure increases. Our calculations also show that when CO2 pressure drops from the current Martian converged condition, H escape flux increases on a timescale of several days and returns to the twice of O escape flux on a timescale of a hundred thousand years. It implies that seasonal drops of the atmospheric pressure due to the CO2 polar ice cap may contribute to the variation of H escape flux. The effect of vertical temperature profile on self-regulation will also be discussed.

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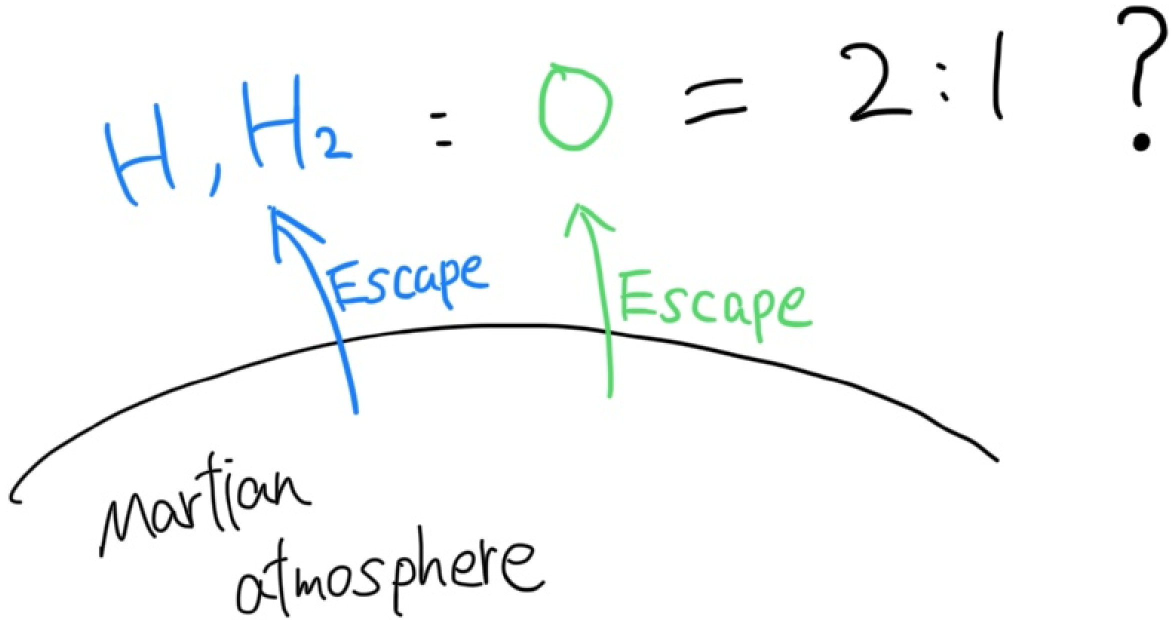
H, H2 : O = 2:1 ?
Escape
Escape
Martian
atmosphere