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Evolution of the Martian surface pressure caused by hot O and C atom escape

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Abstract

Low energetic (few eV) neutral atoms which are produced due to dissociative recombination, photo dissociation, charge exchange and so on in planetary thermospheres play an important role for the escape of heavy atmospheric species at Mars.

The newly photochemically generated energetic neutral atoms, O and C are traced from their point of origin up to the exobase or beyond, by using a 3D Monte-Carlo model and the kinetics and transport characteristics of these particles are determined. The simulation includes the collision of the suprathermal particles with the background gas, energy transfer, and the tracing of secondary and cascaded hot atoms, which are generated in collisions of the hot particles with ambient constituents. A nonlinear electron dissociative recombination coefficient as well as energy and mass dependent collision cross sections and their corresponding scattering angles are also taken into account. In this model we consider elastic, inelastic and quenching collisions between the traced hot particle and the ambient neutral atmosphere. To determine the collision probability the energy and mass dependent total collision cross sections are used. The scattering angle after a collision between the traced hot particle and the background neutrals are chosen randomly from the corresponding differential collision cross section. We also include rotational and vibrational excitation energies for the calculation of the initial energy of the produced hot oxygen and carbon atoms.

With the simulation of the loss rates for O and C over the past, starting from the end of the Noachian Epoch up to now, the loss of the CO_2 atmosphere during the history can be calculated. With these losses one can estimate the evolution of the surface pressure and its influence to the climate conditions and to the planetary habitability caused by hot atom escape.

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