Evolution of atmospheric composition in the early Martian atmosphere

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The purpose of this study is to investigate the evolution of atmospheric composition in the early Martian atmosphere. Not only hydrogen and oxygen but also carbon escape to space is considered in this study. The early Martian atmosphere was influenced by a stronger Sun’ EUV radiation than today. The escape parameter, defined as the ratio of the gravitational potential to kinetic energy at a given altitude, could be small enough to allow massive escapes of these species under such a strong radiation. For example, the escape parameter of atomic carbon in the Martian atmosphere was estimated 0.8 times smaller than that of atomic oxygen and both densities at the exobase level were comparable at 4.1 Gyr ago (Tian et al., 2009). Hence, we consider that in early Mars, thermal escape of atomic carbon could be stronger than atomic oxygen, and oxygen dissociated from CO2 was left behind in the atmosphere. Assuming that the escape rates of atomic carbon and atomic oxygen were in the same proportion, we get results that carbon disappeared in 5 Myrs from 1 bar of CO2 atmosphere and only 0.4 bar of oxygen atmosphere remained around 4.2 Gyr ago. On the other hand, it was suggested that the Martian atmosphere about 3.5 Gyr ago could have several mbar or more of oxygen partial pressure(Noda et al., 2018). In the present study, we have developed a 1-D photochemical model of the early Martian atmosphere to investigate the evolution of the atmospheric composition, in particular from 4.2 to 3.5 Gyr ago. This model includes not only the effect of escapes of hydrogen, oxygen and carbon but also that of deposition to surface and degassing. In this presentation, we will show the influence of the atomic carbon escape to the evolution of oxygen partial pressure left behind in the early Martian atmosphere.

