Possibility of hydrogen peroxide as a warming agent on early Mars with oxidized condition

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Recently, Lanza et al. (2016) reported the detection of the high Mn-oxides abundances of Martian rocks in Gale Crater, where preserves the past martian surface environment during 3–4 Ga. This observation suggests that both liquid water and a highly oxidized atmosphere existed on early Mars, since the precipitation of such a Mn-oxide-rich rock requires highly oxidizing condition in water. On the other hand, the Solar luminosity at 4 Ga would be only 75 % of the current value. Due to this, it is thought that additional greenhouse components in CO2–H2O atmospheres could have played a key role for warming on early Mars on the basis of climate models (e.g., Kasting 1991). However, no previous atmospheric models have shown that highly oxidized atmosphere can warm the mean surface temperature of early Mars above 273 K. As a gaseous material oxidizing martian surface, hydrogen peroxide, H2O2, has been received attention (e.g., Zahnle et al. 2008) On the other side, anyone does not focus on H2O2 as a greenhouse gas, owing to the extremely low abundance in the current Martian atmosphere. Although hydrogen peroxide is photo-chemically unstable, its absorption for far-infrared radiation per a molecule is very strong. Thus, hydrogen peroxide might warm early Mars, if the atmosphere was highly oxidized.
To test this idea, we use a 1-D atmospheric energy balance model with a line-by-line radiative transfer calculation. Then, by parameterizing the abundance of H2O2 in a CO2-dominant atmosphere, we estimate how much the surface temperature is warmed. We found that the temperature increased at most only 3 K, in the case of the atmosphere with the saturated abundance of H2O2. On the other hand, when the abundance of condensation nuclei in the upper atmosphere is low, H2O2 is expected to be possibly super-saturated. In the case of the atmosphere with pressure of > 2bar and 1 ppm H2O2, the surface temperature can exceed 273 K. Also, in the case for 10 ppm H2O2, at least 1 bar atmosphere is required to warm the surface temperature above 273 K. In particular, for the 2 bar atmospheres including H2O2 with a molar fraction of 1 ppm and 10 ppm, the surface temperatures increase about 40 K and 80 K from 230 K, respectively. In this presentation, we will discuss about the possibility that H2O2 concentrates to be super-saturated from the view of photochemical production and condensation processes.

Keywords: Mars, Liquid water, Atmosphere

