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Effects of solar insolation on the stability of clathrates on Mars: Implications for the Martian atmospheric methane

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Mars Express and ground based telescopes recently discovered CH4 in the Martian atmosphere [Formisano et al., 2004; Mumma et al., 2009]. An expectation that it may have a biological origin brings renewed attention to Mars. The observed distribution of CH4 is localized ones [e.g., Formisano et al., 2004; Mumma et al., 2009], which suggests existence of localized sources of CH 4 because the time required for global mixing in the Martian atmosphere is very short. CH4 release from subsurface clathrates has been proposed as a plausible source of CH4. Since the region where clathrates are stable exists in the subsurface Martian environment, CH4 are expected to be stored as methane clathrates when CH4 is delivered or produced in the subsurface. This is likely to occur because the origin of CH4 on Mars could be subsurface biological or geochemical activities (volcanic or hydrothermal reactions such as serpentinization of basalt). Then, dissociation of such clathrates may release CH4 into the atmosphere. Destabilization of clathrates is required for dissociation of clathrates. Here, we show the possibility that solar insolation induces the destabilization of subsurface clathrates. Clathrates are destabilized via temperature increase. If solar heating can increase the temperature in the area of subsurface clathrates, a resultant CH4 release may contribute to the presence of CH4 in the Martian atmosphere.