Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PPS002-05 Room:103 Time:May 25 09:30-09:45

Methane on Mars: Current observations and implication

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Since the simplest organic molecule, methane (CH4), was detected in the Martian atmosphere in 2004, this topic has caused a big interest in the solar system, because its discovery indicates the planet is either biologically or geologically active. Up to now, ground-based and space-born observations have confirmed its presence in the Martian atmosphere (Formisano et al., 2004; Krasnopolsky et al., 2004; Geminale et al., 2008; Mumma et al., 2009; Fonti and Marzo, 2010). However, its reservoirs, release mechanisms, circulation, and sink are still open questions. The high-spectral resolution observation from ground-based telescope indicated that CH4 showed time variation, and non-uniform distribution, with plume-like features at discrete regions (Mumma et al., 2009). Using the Planetary Fourier Spectrometer (PFS) onboard Mars Express (MEX), Geminale et al. (2011) also reported maps of non-uniformed CH4 distribution. Although the MEX/PFS and the ground-based observations were generally not collected at the same time nor did they cover identical areas of Mars, the characteristics of the observed CH4 fields appear to be significantly different. In contrast, photochemistry as currently understood does not produce measurable variations in CH4 concentrations [Lefevre et al., 2009]. Lefevre et al. (2009) suggested an atmospheric lifetime of less than 200 days is necessary to reproduce the local CH4 enhancements similar to those recently reported, which implies an unidentified CH4 loss process that is 600 times faster than predicted by standard photochemistry. In summary, current photochemical models cannot explain the observed presence of CH4 in the atmosphere of Mars and its reported rapid variations in space and time. The origin and sink of CH4 on Mars remains a puzzle. In the near future, the observations using heterodyne spectroscopy with an alternative CH4 band near 7.8 um [Sonnabend et al., 2008] are begun to monitor CH4 from the ground, and the tunable laser spectrometer measurements is carried out at the Martian surface on the 2011 Mars Science Laboratory (MSL) to identify the isotope of CH4 [Webstar et al., 2011]. Joint orbiter mission being considered by ESA and NASA (JIDT) is also expected to provide the significant scientific progress on this issue by investigating the nature of the trace gas with measurements of temperature and aerosols (Zurek et al., 2011). Here we review the current observations of Martian CH4 and their implications.

Keywords: Mars, Methane, Life, Habitability