

PPS002-06

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MEX/PFSによる火星大気中H₂O₂の導出 Search of H₂O₂ in the Martian atmosphere by MEX/PFS

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Recently, a small amount of CH₄ was discovered in the Martian atmosphere. This discovery is remarkable because its sources are potentially biological or geological actives. However, its source, circulation and sink are still open questions. Recent observations showed the temporal and spatial variation of CH₄, which requires fast loss, which might indicate strong oxidants. H₂O₂ would be the best tracer for the amount of possible oxidants in the Martian atmosphere. However, past ground-based and space-born observations were very limited. Thus, the temporal and spatial variations of H₂O₂ have not been understood yet.

H₂O₂ has not detected from a Martian orbiter because it required high-spectral resolution in order to distinguish between weak absorption lines of H₂O₂ (~0.1% of the background radiance) and stronger absorptions by H₂O. At the moment, the Planetary Fourier Spectrometer (PFS) onboard Mars Express (MEX) is the best instrument for this objective, which has been successfully operated for seven years. It possesses the highest spectral resolution in the mid-IR range (~1.3 cm⁻¹) in previous orbiters. However, even this resolution could not completely separate H₂O₂ from H₂O. We need careful treatment in the analysis.

In our study, we select the wavelength range from 360 to 385 cm⁻¹ where the contamination of H₂O₂ by H₂O is minimum. And, the sensitive calibration was performed: (1) FFT with the Hamming apodization, (2) characterization of a weak instrumental noise, and (3) careful averaging several thousands of measurements. In order to retrieve the mixing ratio of H₂O₂, the radiative transfer model for the Martian atmosphere has also been developed. By the comparison of the observed spectra with the model, we succeeded to determine the mixing ratio of Martian H₂O₂ with the accuracy of several tens ppb. By this method, (1) total average, (2) annual variation, and (3) seasonal variation of the H₂O₂ mixing ratio was obtained with the data observed 3 Martian years (Jan. 2004 - Dec. 2009). The main results are summarized as follows.

(1) Total average: Total averaged H₂O₂ mixing ratios have been successfully determined to be 45 +- 21 ppb in the forward pendulum direction, and 25 +- 18 ppb in the reverse pendulum direction, respectively.

(2) Annual variation: The annual mean amount of H₂O₂ in the three Martian years (MY 27, 28, and 29) was investigated. The mixing ratios of H₂O₂ were 50 +- 27 ppb and 43 +- 26 ppb at the MY 27, 0 - 89 ppb and 0 - 74 ppb at the MY 28 (upper limits), and 46 +- 21 ppb and 28 +- 20 ppb at the MY 29, respectively

(3) Seasonal variation: It shows the variation from 0 to 120 ppb during the observational period, with an average of 39 +- 16 ppb in total data set.

In all results of (1)-(3), derived amount of H₂O₂ is slightly larger than that predicted by the photochemical models and past observations. This discrepancy would be due to (1) the bias of data selection; the high Martian temperature (only 250-270K)> and the local time (only 10-16), and/or (2) the contribution of large but short enhancement in long-term average. In addition, it was noticed that the observational variations of CH₄ reported by previous works would not be explained by the process of photochemical loss even with our results.

キーワード: 火星, 大気, 赤外分光, メタン, 過酸化水素, 酸化

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