EPSC Abstracts
Vol. 9, EPSC2014-505-2, 2014
European Planetary Science Congress 2014

Observation of CO_2 ice clouds in the Martian mesosphere using PFS onboard Mars Express

Y.Sato (1), Y.Kasaba (1), M.Giuranna (2), S.Aoki (1,2), H.Nakagawa (1), T.Kuroda (1)
(1) Tohoku University, Japan (2) Istituto di Astrofisica e Planetologia Spaziali, INAF,Italy

Abstract

We succeeded in detecting CO_2 ice clouds using Planetary Fourier Spectrometer (PFS) on board Mars Express. The spectra obtained by PFS showed the spectral signature of CO_2 ice clouds, which exhibits single distinct spike at 4.26 μm [3]. However, The spike feature was appeared at 4.25 μm with high spectral resolution of PFS. We confirmed that the spike feature of spectra was the signature of CO_2 ice clouds by simultaneous observation between PFS and OMEGA.

In some case, the peak of spectra was resolved into two parts, at 4.25 μm and 4.28 μm. These two types of spectral characteristics may suggest difference of cloud features for example, size distribution of cloud particle, particle shape and cloud condensation nuclei. Thus observations with high spectral resolution of PFS can address the optical properties of CO_2 ice clouds.

1. Introduction

The atmosphere of Mars consists of 95% carbon dioxide. It can condense in high altitude regions (> 60km) ,which results in the formation of CO_2 ice clouds [2,3,4]. Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activé (OMEGA), visible and near-infrared imaging spectrometer onboard Mars Express has provided the spectral signature of CO2 ice clouds, which exhibits single distinct peaks at 4.26 μm inside a CO_2 gas absorption at 4.3 μm [3].

According to recent study, the most of CO_2 ice clouds were observed around equator, and some clouds were detected around mid-latitude in autumn [1,2,3,4].

[3] has analyzed some properties of the clouds (particle size, opacity, and altitudes) using shadow observation by OMEGA. However, the particle size obtained by the analysis of cloud observations has not an agreement with the calculated estimation by a radiative transfer model. Thus it is necessary for estimating particle size to observe cloud with higher spectral resolution.

PFS has the highest spectral resolution (~1.3cm^{-1}) in the spectral ranges among the current instruments. The spectral resolution of PFS is about ten times higher than that of OMEGA. It allows us to investigate the optical properties of CO_2 ice clouds. In this study, we attempted to detect CO_2 ice clouds as the first step.

2. Detection of CO_2 ice clouds by PFS

2.1 Single peak feature : simultaneous observation with OMEGA

PFS has a number of simultaneous measurements for CO_2 ice clouds with OMEGA. We analyzed the data for ten orbits where OMEGA detected CO_2 ice clouds with nadir geometry.

Spectra obtained by PFS showed a feature like the signal of CO_2 ice clouds with spike shape at around 4.25 μm. PFS showed the spike more clearly with high spectral resolution, though the position of the spike feature slightly shifted toward shorter wavelength in comparison with the spectra Obtained by OMEGA (Figure1).

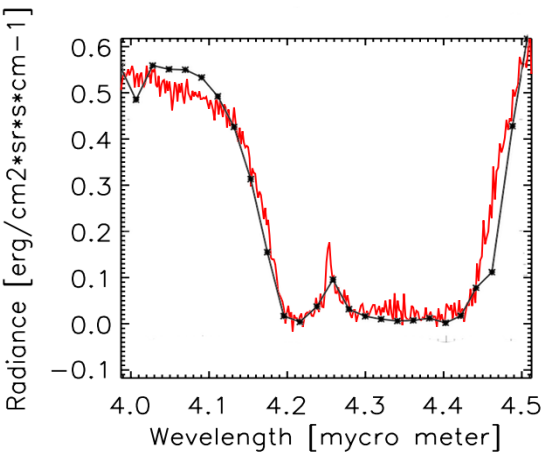

Figure 1 : Spectra obtained by PFS (red) and OMEGA (black) on Orbit 5267.

In order to verify whether this signal is real or not, we compared with the data obtained by PFS with that by OMEGA. Since the spike at 4.25 μm showed up only when observation area of PFS was consistent with where OMEGA detected CO_2 ice clouds, we can conclude that the spectral feature obtained by PFS is due to CO_2 ice clouds.

2.2 Double-peak feature

In some spectra obtained by PFS, we found the spectral feature with two peaks at 4.25 μm and 4.28 μm. (Figure 2). This spectral feature was seen only by PFS because of its high spectral resolution.

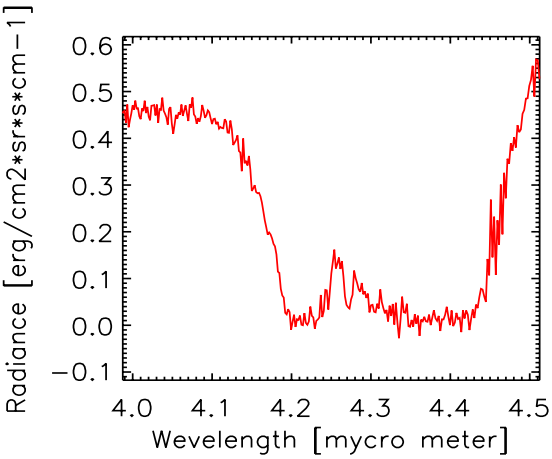

Figure 2 : The spectrum obtained by PFS showing double-peak feature at 4.25 μm and 4.28 μm.

We assumed that the difference of spectral features (single- and double-peak) suggest different characteristics of clouds, for example size distribution particle, particle shape and cloud condensation nuclei. For further investigations, we will calculate synthetic spectrum by using the discrete-ordinate-method (DISORT) radiative transfer model assuming several size distributions, and estimating the particle radii of CO_2 ice clouds.

Reference

[1] Clancy, R. T., and B. J. Sandor : CO_2 ice clouds in the upper atmosphere of Mars, GRL,25(4), 489–492,1998

[2] Määttänen et al. : Mapping the mesospheric CO_2 clouds on Mars: MEx/OMEGA and MEx/HRSC observations and challenges for atmospheric models, Icarus, 209,452-469, 2010

[3] Montmessin, F. et al. : Hyper-spectral imaging of convective CO_2 ice clouds in the equatorial mesosphere of Mars, JGR, 112, E11S90,2007

[4] Vincendon, M. et al. : New near-IR observations of mesospheric CO_2 and H_2O clouds on Mars, JGR,116, 2011