

Study of H₂O and CO in Martian atmosphere with PFS/MEX data

G. Sindoni, V. Formisano

Istituto di Fisica dello Spazio Interplanetario (IFSI) – INAF, Rome, Italy (giuseppe.sindoni@ifsi-roma.inaf.it)

Abstract

The Planetary Fourier Spectrometer (PFS) on board of the Mars Express orbiter can sound the Martian atmosphere. The retrieval of the water vapour and of the carbon monoxide abundances is obtained from the analysis of the 3845 cm⁻¹ (2.6 μm) and the 4235 cm⁻¹ (2.36 μm) absorption bands, respectively. Mapping the seasonal and geographical distribution of these two atmospheric gaseous species, we found the expected behaviour, measuring a mean water vapour mixing ratio of 127 ppm and a mean carbon monoxide mixing ratio of 991 ppm.

1. Introduction

In the history of the Mars exploration its atmosphere and planetary climatology has from time aroused particular interest. In the study of the minor gas abundance in the Martian CO₂ atmosphere, the water vapour assumes particular importance, both because it is the most variable trace gas, and because it is involved in several processes characterizing the planetary atmosphere.

The water vapour photolysis regulates the Martian atmosphere photochemistry, and so it is strictly bounded to the carbon monoxide. The CO study is very important for the so called “atmosphere stability problem” [1] (the whole CO₂ atmosphere should be destroyed in 6000 years by photolysis), solved by the theoretical modelling involving photochemical reactions in which the H₂O and the CO gases are main characters.

2. Dataset and Analysis

The Planetary Fourier Spectrometer (PFS) on board of ESA Mars Express (MEX) mission can probe the Mars atmosphere in the infrared spectral range between 200 and 2000 cm⁻¹ (5-50 μm) with the Long wavelength channel (LWC) and between 1700 and 8000 cm⁻¹ (1.2-5.8 μm) with the Short wavelength

channel (SWC) [3]. The used dataset covers more than two and half Martian years from $L_s = 62^\circ$ of MY 27 (orbit 634) to $L_s = 203^\circ$ of MY 29 (orbit 6537). Although there are several H₂O and CO absorption bands in the spectral range covered by PFS, we chose to use the 3845 cm⁻¹ (2.6 μm) band for the water vapour and the 4235 cm⁻¹ (2.36 μm) band for the CO analysis, because these ranges are less affected by instrumental problems respect to other ones. The gaseous abundances are retrieved by using a particular algorithm developed for this purpose. The analysis procedure is based on the best fit between the measured averaged spectrum and a synthetic one appositely generated in each step of the fitting loop.

3. Results and Conclusions

The averaged water vapour mixing ratio results to be 127 ppm, while the averaged carbon monoxide mixing ratio results to be 991 ppm, but with strong seasonal variations at high latitudes. The seasonal water vapour map reproduces very well the known *seasonal water cycle* [4],[5],[6],[7],[8]. In the northern summer the water vapour and CO show a good anticorrelation most of the time, i.e. water has its maximum and carbon monoxide has its minimum mixing ratio over the north pole. This behaviour is due to the carbon dioxide and water sublimation from the north polar ice cap, which dilutes noncondensable species including carbon monoxide. An analogous process takes place during the winter polar cap, but in this case the carbon dioxide and water condensation causes an increase of the abundance of noncondensable species. Therefore, the carbon monoxide mixing ratio varies in response to the mean seasonal cycle of surface pressure [2].

Occasionally the CO has a second maximum also at the north pole. The study of these unexpected features is in progress.

Acknowledgements

PFS experiment has been built at the Istituto di Fisica dello Spazio Interplanetario (IFSI) of Istituto Nazionale di Astrofisica (INAF), and has been funded by the Italian Space Agency (ASI) in the context of the Italian participation to the Mars Express mission of ESA. The authors are very grateful to A. Mattana for his data processing support.

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