

O₂ abundance on Mars observed by Mars Express / SPICAM

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Abstract

The stability of the Martian atmosphere is coupled with the photochemically produced minor species such as O₂. Up to now only a few measured data are available of O₂ abundances on Mars. We retrieved altitude profiles of O₂ by analyzing stellar occultations observed by the SPICAM ultraviolet instrument on-board Mars Express. The O₂ profile is determined in the altitude range between 90 and 140 km. The derived mixing ratios in this area are between 1×10^{-3} and 5×10^{-3} which are in agreement with those obtained from Viking measurements in 1976.

1. Introduction

The stability of the Martian atmosphere is connected to minor species like O₂ which are produced photochemically. The global O₂ distribution in the region where photochemistry is important is not well known. A better understanding of the O₂ distribution is important for constraining models for the Martian atmosphere.

In the past only a few observations of O₂ are available, from the Viking mass spectrometer where [5] obtained densities and mole fraction for O₂. Their retrieved mole fractions are between 2×10^{-3} and 4×10^{-3} in the altitude range between 120 and 160 km. [2] recently presented the first O₂ 1.27 μ m nightglow emissions at Mars from the OMEGA imaging spectrometer observations onboard of Mars Express but for altitudes lower than 90 km.

Stellar occultations observed by SPICAM can be used to retrieve the density profiles of CO₂, O₃, O₂, and aerosols [4, 6]. We present the first O₂ abundance profiles from below 120 km in the Martian atmosphere - a region important for constraining photochemical models.

2. SPICAM Occultations

The SPICAM UV spectrograph from covers the wavelength range from 110 to 310 nm with a spectral resolution of around 1.5 nm [1].

Above the atmosphere the line of sight, pointing to the star, is unattenuated and thus the unabsorbed reference spectrum from the star is measured. By moving along the trajectory of the spacecraft the line of sight penetrates the atmosphere and the star spectrum attenuated by the atmosphere is measured. The transmission is obtained by dividing the attenuated spectrum by the unabsorbed spectrum. This method has the advantage that no absolute calibration of the spectograph is need.

We fit the measured transmission spectra at each altitude by using the CO₂ and O₂ absorption cross sections and the Levenberg-Marquardt algorithm to retrieve the best fit column densities. We invert the column density profiles by using the Tikhonov regularization method to obtain number densities [6].

3. Results and Discussions

The CO₂ and O₂ densities for four different occultations are shown in Figure 1. The CO₂ and O₂ densities measured from Viking 1 and 2 are also shown. The triangles pointing upward represent Viking 1 and the downward pointing ones represent Viking 2 densities. The O₂ densities inferred from SPICAM measurements are in a good agreement with Viking in the overlapping region. The CO₂ abundances are showing a seasonal dependency, higher CO₂ densities for higher L_s (longitude of the Sun) values, which is also in agreement with [3].

The altitude dependent mole fractions, for the same four occultations as in Figure 1, are show in Figure 2 together with those obtained by Viking 1 and 2. The mean values of the mole fractions obtained from SPICAM measurements are between 1×10^{-3}

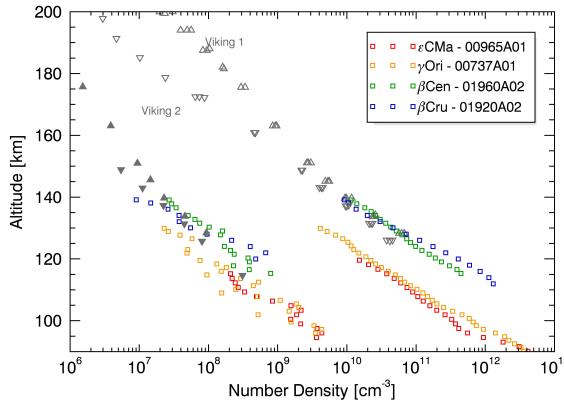


Figure 1: O_2 and CO_2 abundances for four different SPICAM occultations (colored squares) and measurements from Viking 1 (gray upward pointing triangles) and Viking 2 (gray downward pointing triangles).

and 5×10^{-3} , depending on the season and latitude. These values are in agreement with the mole fractions between 2 and 4×10^{-3} obtained from Viking measurements.

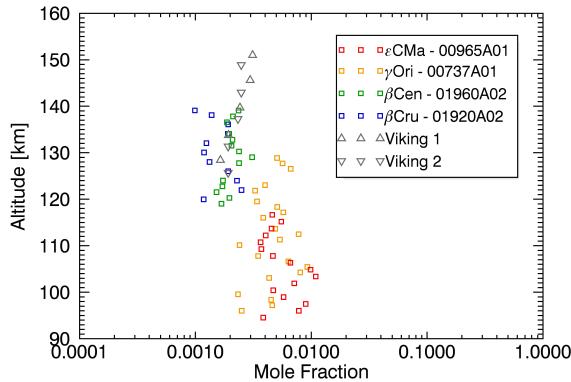


Figure 2: Mole fractions for four different SPICAM occultations (colored squares) and measurements from Viking 1 (gray upward pointing triangles) and Viking 2 (gray downward pointing triangles).

SPICAM, and CNRS and CNES for financial support.

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Acknowledgements

Work at the University of Arizona was supported by NASA as part of their ongoing collaboration on the Mars Express experiments, and by NASA Grant NNX09AH52G. We thank our collaborators at LATMOS, BIRA, and IKI for the design and fabrication of