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Mars Mesospheric Winds around Northern Spring Equinox from High Resolution Infrared Spectroscopy

G. Sonnabend (1), M. Sornig (1), P. Kroetz (1), D. Stupar (1), R. Schieder (1), L. Montabone (2), K. Fast (3)

(1) I. Physikalisches Institut, University of Cologne, Cologne, Germany, (sornig@ph1.uni-koeln.de / Fax: +49-221-4705162), (2) The Open University, Milton Keynes, UK, (3) NASA GSFC, Greenbelt, Md, USA

Abstract

We present observations of mesospheric winds on Mars around northern Spring Equinox. Data was gathered using ground based ultra-high resolution spectroscopic observations of CO_2 features around 10 μm wavelength. Observations were carried out during three seasons (L_S=335, 357, 40) using the Cologne Tuneable Heterodyne Infrared Spectrometer (THIS) [1] at the McMath-Pierce Solar Telescope on Kitt Peak, Arizona and the NASA InfraRed Telescope Facility on Mauna Kea, Hawaii.

Heterodyne techniques allow a spectral resolution of more than 10^7 and thus the observation of fully resolved molecular features and the retrieval of Doppler-shifts down to $\sim$1 MHz. In the case of our observations this corresponds to an accuracy of 10 m/s. In addition the high spatial resolution on the planetary disk intrinsic to infrared wavelength enables unique ground-based studies of latitudinal variations.

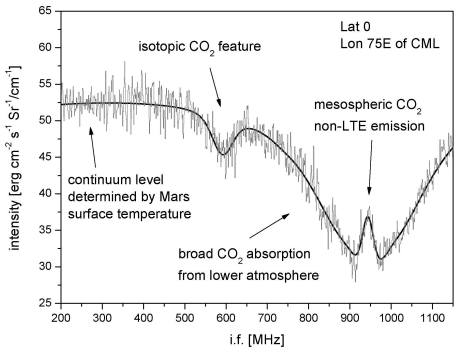

Figure 1: A typical spectrum of absorption and emission features of the P(2) CO_2 transition to retrieve Doppler-shifted wind velocities on Mars.

In the atmosphere of Mars non-LTE processes lead to an enhanced mesospheric emission of CO_2 molecules in the 9 and 10 μm band. These narrow emission features can be used to measure Doppler-shifts induced by winds [2, 3]. The non-LTE emission is contributed from the Mesosphere (50–90 km altitude) and is superimposed to a broad absorption feature from the low atmosphere creating the characteristic profiles shown in Fig. 1. Due to the small line width of the emission features ($\sim$25 MHz FWHM) ultra high spectral resolution of $> \frac{\nu}{\Delta\nu} > 10^6$ is required.

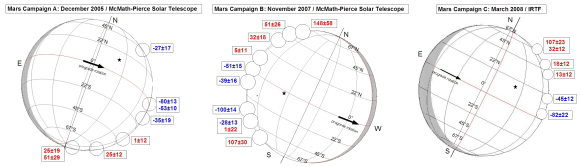

Figure 2: *Overview of retrieved results for zonal wind velocities on Mars during the three Mars campaigns. Wind velocities are given in m/s, prograde wind velocities are written in red whereas blue numbers indicate retrograde wind velocities.*

Season A (L_S=335) and B (L_S=357) were observed in Nov 2005 and 2007, respectively, using the McMath-Pierce telescope in Arizon. Season C (L_S=40) was observed in Mar 2008 using the IRTF on Hawaii. A first comparison to model predictions from the Mars Climate Database [4] was performed. Results from all runs show a good agreement between the data and the predictions with possible higher wind values at the high latitudes.

References

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