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Mars Mesospheric Winds around Northern Hemisphere Summer Solstice from High Resolution Infrared Spectroscopy

P. Krause (1), C. Reinerth (1), G. Sonnabend (1), M. Sornig (1,2), T. Stangier (1,2) and M. Herrmann (1)
(1) University of Cologne, Ist Institute of Physics, Germany, (2) RIU - Department of Planetary Research, Germany
(pkrause@ph1.uni-koeln.de)

Abstract

We present observations of mesospheric zonal winds on Mars around northern hemisphere Summer Solstice. Data was gathered using ground based ultra-high resolution spectroscopic observations of CO_2 features around 10 μm wavelength. Observations were carried out during March 2012 using the Cologne Tuneable Heterodyne Infrared Spectrometer (THIS) [1] at the McMath-Pierce Solar Telescope on Kitt Peak, Arizona.

1. Introduction

General circulation models (GCM) for Mars have evolved to a state allowing detailed predictions of atmospheric dynamics. In this models wind speeds are a key variable and therefor need to be validated by observations. To measure wind speeds in the atmosphere of Mars a ultra high spectral resolution of $\frac{\vartheta}{\Delta\vartheta} > 10^6$ is required. Non-LTE processes in the atmosphere of emission features can be used to measure Doppler-shifts induced by winds. [2,3]. The non-LTE emission is contributed from the Mesosphere (50-90km) and is embedded in a broad absorption feature from the low atmosphere as shown in Fig. 1. A frequency shift between the absorption an emission component can be directly converted to a line-of-sight velocity and, given the observation geometry, into a zonal wind shear between the two altitude regions [2,3]. 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 corespondents to an accuracy of 10 m/s.

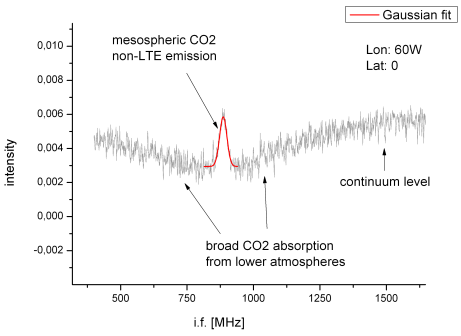

Figure 1: The heterodyne spectrum with the non-LTE P(12) CO_2 peak used for the measurement of Doppler-Shifted wind velocities.

Mars leads to an enhanced mesospheric emission of CO_2 molecules in the 9 and 10 μm band. These narrow

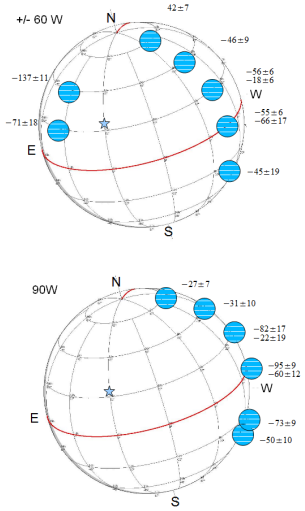

Figure 2: Observed positions and results for zonal wind during the Mars campaign in March 2012. Wind velocities are given in m/s. West wind is negative, east wind is positive.

2. Observations

Observations of the P(12) CO_2 line on the day side of Mars were realized during an observing run in March 2012 at the McMath-Pierce Solar Telescope on Kitt Peak, Arizona using the spectrometer THIS. During this run Mars was closed to the northern hemisphere Summer Solstice (L_S=90°). Various spectral were taken to provide a good latitudinal coverage.

3. Results

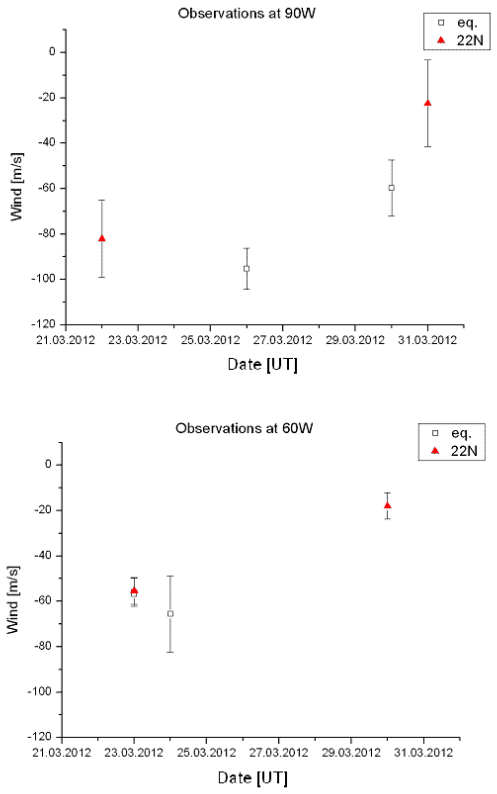

Figure 3: In this figure the wind speed at two fixed latitudinal positions (△ 22N and □ equator) is plotted against the observation date, to show the variation in time.

Fig. 2 shows the wind speeds determined from the non-LTE emission lines. This observation run delivers a good survey of the mesopheric zonal wind on the different latitudes of Mars around the northern Summer Solstice. To determine the wind variability on Mars several positions were observed twice during this observation run. Fig. 3 shows a overview of this positions. As one can see, according to the data, the wind speed changed drastically over the time of the observing run. The data analysis is still ongoing. The measured data will be used for comparison with the model predictions of the Mars Climate Database (MCD) [4] in order to verify the model in this particular case.

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