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Investigation of CO_2 Absorption Features on Venus

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Abstract

We will present investigations of ground-based observed CO_2 absorption lines around 10 μm in the Venusian atmosphere using ultra high resolution spectroscopy. Data was acquired over the whole planetary disc with focus on the night-side, probing an altitude region between 60 km and 90 km. Many different temperature profiles were generated lately by measurements as well as model predictions to describe the vertical behavior of the atmosphere. Reference analysis shall present first results on the reliability of the various profiles.

1. Introduction

In recent years the spacecraft mission VenusExpress was able to collect lots of information about the atmospheric behavior of the planet. Especially vertical temperature profiles were improved and a cross validation with detailed ground-based observations can provide insights on the reliability and accuracy of the predictions. Spectral analysis of fully resolved absorption features of CO_2 in the transition region between the main cloud layers (60 km) and the cryosphere (100 km) will be performed in order to determine spatial and temporal behavior and variability.
CO_2 in the Venusian stratosphere is an important constituent to investigate the atmospheric structure and composition. On the warm day-side of the planet carbon dioxide emits, due to solar radiation, strong non local thermodynamic equilibrium (LTE) features at low pressure levels in the mesosphere around 110 km altitude. These emission lines were first detected at 10 μm by *Betz et al.* [2]. Thus, non-LTE features are supposed to be totally absent on the Venusian night-side. Investigations of the dark side of the planet showed an inversion of the temperature at around 59 km altitude [7]. This temperature inversion provokes absorption features of CO_2 even in high altitude region between 60 km to 95 km. Hence, CO_2 absorption lines can be used as probes for cloud properties and temperature variations above the main cloud layers.
To investigate these absorption lines, one requires very high spectral resolution of 10^7 in order to fit single line profiles. In the mid-infrared wavelength region, only heterodyne technique enables the opportunity to resolve single transition lines to determine its characteristics. Besides it yields an enhancement in spatial resolution compared to measurements at higher wavelength.

2. Observations

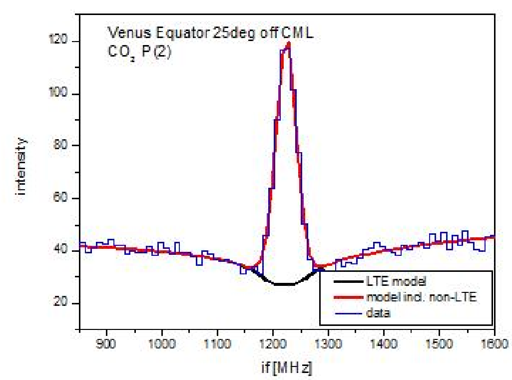

Figure 1: Example of a CO_2 features at 10 μm. A LTE absorption line with a strong non-LTE emission core can be observed. The black line indicates the LTE-model using a temperature profile from VEX Radio-Science [7].

First measurements of CO_2 absorption lines were performed using the Cologne Tuneable Heterodyne Infrared Spectrometer (THIS) which was developed at the University of Cologne [6]. The tuning range of THIS covers the wavelength region from 7 μm to 13 μm. In Fig. 1 a fully resolved CO_2 absorption line with a strong non-LTE emission core at around 10.4 μm is displayed. This observation was performed in 2007 at the McMath-Pierce Solar Telescope on Kitt Peak, AZ on the day-side of Venus. The atmosphere was probed in mid-latitude regions around the equator close to the terminator (day-night transition line). The LTE contribution of the CO_2 feature was fitted with the full radiative transfer code CODAT [3]. A coresponding (time and location) temperature profile from VeRa [7] observation was used as input information. Further data was acquired on the Venusian night-side in 2009 which will be included in the future analysezing process.

3. Outlook

The observational goal is to determine spatial variations of the absorption features as well as a possible temporal behavior. Concentration of the molecule can be derived from the absorption depth of the feature whereas the line width provides information about the dominating pressure level or temperature.
The high spatial resolution of the infrared heterodyne instrument enables to point at different spots along the planet. Hence, latitudinal and longitudinal profiles along the Venusian dark-side will be investigated. A deviation of the line shape is going to be expected especially along different latitudes from the equatorial region towards the poles.
Besides, a reference analysis of expected absorption lines to measured spectra will be performed, taking various vertical temperature profiles such as VIRA [5], VeRa [7], Virtis [1], PVO [4] into account.

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