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Density and temperatures of Venus upper atmosphere measured by stellar occultations with SPICAV/Venus Express

A. Piccialli (1), F. Montmessin (1), J. L. Bertaux (1), E. Marcq (1), A. Fedorova (2), O. Korablev (2), A. Mahieux (3), A. C. Vandaele (3)
(1) LATMOS-UVSQ, Guyancourt, France, (2) Space Research Institute (IKI), 84/32 Profsoyuznaya, 117810 Moscow, Russia, (3) Planetary Aeronomy, Belgian Institute for Space Aeronomy, Brussels, Belgium (arianna.piccialli@latmos.ipsl.fr)

Abstract

We will present a preliminary study of the Venus atmospheric structure between 90 and 140 km of altitude using SPICAV-UV/VEx stellar occultation observations. More than 500 density and temperature profiles were retrieved at various latitudes and local time. The upper atmosphere of Venus shows a very large temporal variability; variations both from orbit-to-orbit and with local time are observed.

1. Introduction

Venus upper atmosphere (80-140 km altitude) is one of the most interesting regions on the planet. It is a transition region characterized by a complex dynamics: strong retrograde zonal winds dominate the lower mesosphere while a solar–antisolar circulation driven by a day-to-night temperature gradient can be observed in the upper mesosphere/lower thermosphere. CO_2 density and temperature profiles of Venus upper atmosphere have been measured from both ground-based [1, 2] and spacecraft missions [3, 4]. The thermal structure of Venus mesosphere shows a significant latitudinal variability probably driven by the dynamics. Atmospheric temperatures reach a minimum value of ≈ 170 K at 90–100 km altitudes on the dayside of the planet. More recently, a layer of warm air has been detected at altitudes of 90-120 km on the nightside both by SPICAV/SOIR [5, 6] and by ground-based [7] observations.

2. Observations

The SPICAV (Spectroscopy for the investigation of the characteristics of the atmosphere of Venus) [8] instrument has been operating on board the ESA orbiting platform Venus Express since 2006. It is a remote sensing spectrometer covering distinct spectral regions in ultraviolet (118–320 nm) and near-infrared (650–1700 nm). In the stellar occultation mode the UV sensor is particularly well suited to measure the vertical profiles of CO_2, temperature, SO_2, SO, clouds and aerosols of the middle and upper atmosphere of Venus. A very large dataset has been collected by SPICAV-UV that consists of more than 500 stellar occultation profiles performed at all latitudes and seasons during nighttime (Fig. 1).

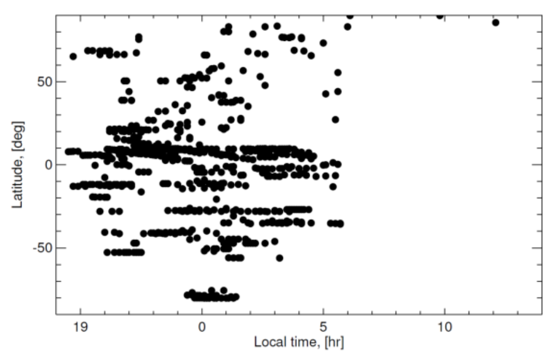

Figure 1: distribution of SPICAV-UV stellar occultations in local time and latitude.

3. Results

CO_2 density and temperature profiles were derived by SPICAV-UV stellar occultations covering the altitude range 90 – 140 km (Fig. 2).

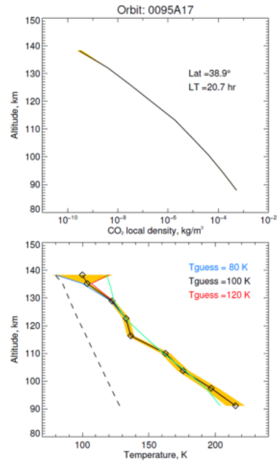

Figure 2: Example of (top) CO_2 density and (bottom) temperature profiles for orbit 95A17.

Fig. 3 displays the local time – altitude cross section of atmospheric temperature. A permanent warm area appears distinctly at the mesopause at about 90-100 km of altitude. Temperature then decreases with altitude reaching a minimum value around 125 km altitude in good agreement with previous observations [6]. Spatial and temporal changes in the thermal structure are analysed.

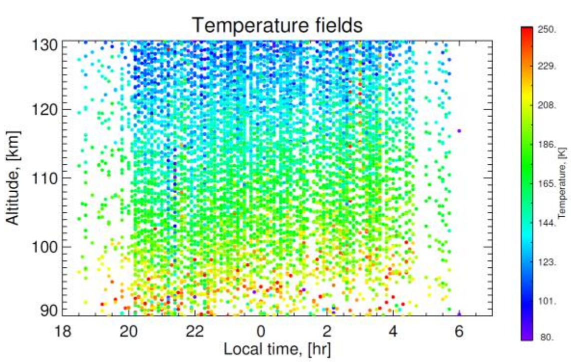

Figure 3: local time – altitude cross section of atmospheric temperature (K). All SPICAV-UV stellar occultations have been used.

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