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Zonal winds in the Venus mesosphere from VIRTIS/VEx temperature sounding

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Introduction

We present zonal thermal winds derived by applying the cyclostrophic balance from the Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) temperature retrievals. VIRTIS was one of the experiments on board the European mission Venus Express [1]. It consisted of two channels: VIRTIS-M and VIRTIS-H. For this study, we will analyze the complete VIRTIS dataset acquired between December 2006 and January 2010 [2,3].

Mesosphere dynamics

Venus mesosphere (60 – 100 km altitude) is a transition region characterized by different dynamical regimes. A retrograde super-rotation dominates in the lower part above the cloud top (>70 km) with wind speeds of about 100 m s^{-1}, while a solar-antisolar circulation, driven by the day-night contrast in solar heating, can be observed above 120 km. The processes responsible for maintaining the zonal super-rotation in the lower atmosphere and its transition to the solar-antisolar circulation in the upper atmosphere are still poorly understood [4].

Different techniques have been used to obtain direct observations of wind at various altitudes: tracking of clouds in ultraviolet (UV) and near infrared (NIR) images give information on wind speed at cloud top (~70 km altitude) [5] and within the clouds (~61 km, ~66 km) [6], while ground-based measurements of dopplershift in CO_2 band at 10 μm [7] and in several CO (sub-)millimeter lines [8,9] sound thermospheric and upper mesospheric winds, showing strong variability.

In the mesosphere, at altitudes where direct observations of wind are not possible, zonal wind fields can be derived from the vertical temperature structure using the thermal wind equation. Previous studies [10,11,12] showed that on slowly rotating planets, like Venus and Titan, the strong zonal winds at cloud top can be successfully described by an approximation of the Navier–Stokes equation, the cyclostrophic balance in which equatorward component of centrifugal force is balanced by meridional pressure gradient.

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