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Zonal winds in Venus mesosphere from VIRTIS/VEx temperature retrievals

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Venus is a natural laboratory to study the atmospheric circulation on a slowly rotating planet. The dynamics of its upper atmosphere (60-120 km) is a combination of retrograde zonal wind found in the lower mesosphere and solar-to-antisolar winds that characterize the thermosphere, and it is subject to a strong turbulence and a dramatic variability both on day-to-day as well as longer timescales. Moreover, several wavelike motions with different length scales have been detected at these altitudes within and above the clouds and they are supposed to play an important role in the maintenance of the atmospheric circulation. The basic processes maintaining the super-rotation (an atmospheric circulation located at the clouds level and being 80 times faster than the rotation of the planet itself) and other dynamical features of Venus circulation are still poorly understood [1].

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) [2] and within the clouds (~61 km, ~66 km) [3], while ground-based measurements of doppler-shift in CO_2 band at 10 μm [4] and in several CO (sub-)millimeter lines [5,6] sound thermospheric and upper mesospheric winds, showing a 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 [7,8,9] 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.

We will present zonal thermal winds derived by applying the cyclostrophic approximation from the Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) temperature retrievals. VIRTIS was one of the experiments on board the European mission Venus Express [10]. For this study, we will analyze the complete VIRTIS dataset acquired between December 2006 and January 2010 [11,12].

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