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Winds and cloud morphology in the southern polar region of Venus

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Abstract

Spinning on average 60 times faster than the surface, the atmosphere of Venus is superrotational, a state in which the averaged angular momentum is much greater than that corresponding to co-rotation with the solid globe. The rapid mean flow, which is maintained by momentum transports in the deep atmosphere, presents a puzzle to the atmospheric and planetary sciences[1]. After previous missions revealed a bright polar feature at the north pole[9, 10], the Venus Express spacecraft discovered a fast-rotating counterpart at the southern polar region[6], which has been identified as a vortex[2]. The southern polar vortex can be observed at 5.0 μm as a bright, highly variable structure which is ~ 15 K warmer than the surrounding air[6]. Although the Venus superrotation has been measured by tracking cloud features at UV and infrared wavelengths[7, 4, 8, 5], the winds in the polar region remain poorly constrained. Characterizing the zonal and meridional circulation in this region, as well as their variability, is crucial for understanding the mechanisms that maintain superrotation. In particular, mean zonal winds are necessary to understand the nature of the polar vortex, how it is connected with the general circulation of the atmosphere, and to diagnose momentum transports.

Winds at 45 and 65 km can be detected from cloud motion monitoring by the VIRTIS-M subsection onboard the Venus Express (VEX) spacecraft. Our objective is to provide direct wind measurements at cloud tops and in the lower cloud level, in order to help interpret the VEX observations concerning the mesospheric wind regime and temperature fields. In particular, we present direct measurements of the zonal and meridional winds at both altitudes.

For this work we selected nadir-pointing, high-spatial resolution VIRTIS data cubes obtained from apocenter in order to minimize the geometric distortion of the polar region. On average these contain latitudes extending from the pole to 70S. Since the VIRTIS field of view is rectangular, lower latitudes are also present but cannot be observed over full latitude circles.

Cloud tracking has been performed using the method of digital correlation described in a previous article[3]. VEX orbits were selected so as to have in each one at least one pair of images suitable for tracking, i.e., with a considerable spatial overlap. Tracking has been performed on pairs of monochromatic images at wavelengths of 1.74 μm, 2.3 μm, 3.93 μm and 5 μm.

In the data cubes obtained with longer integration times (3s) the long-wavelength range of the spectrum, above 4.3 μm, is saturated. In those cases we selected the 3.93 μm radiance map instead of the one at 5 μm. The monochromatic radiance maps are first extracted from data cubes that have undergone the standard VIRTIS calibration procedures. The maps are then projected onto a polar stereographic grid and the wind retrieval procedure is applied. A total of 20 latitude bins, separated by 1 degree were used. For the analysis of transient motions the spatial averaging was done in 72 longitude bins at 5 degree intervals.

In order to evaluate the variability over the time scale of one orbit, we have computed the orbital averages, i.e., averages of all measurements coming from one given orbit. These orbital averages are only approximations to temporal averages, since they do not cover one full rotation. The differences between same-orbit averages are apparent in both day and night side averages. Some notable features indicating different day and night side regimes are also apparent in the orbit averages, and the boundary of the cold collar appears to be a transition latitude. Moreover, the variability that can be observed from orbit to orbit and between series of observations from the same orbit indicates that departures from this mean flow are large and

a persistent feature of the global circulation.

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References

[1] Gierasch, P. et al. : The general circulation of the Venus atmosphere: an assessment. In S. W. Bougher, D. M. Hunten and R. J. Philips (Eds.), Venus II: Geology, geophysics, atmosphere, and solar wind environment, Arizona University Press, 1997

[2] Limaye, S. S. et al. : Vortex circulation on Venus: dynamical similarities with terrestrial hurricanes, Geophys. Res. Lett., 36, L04204, 2009.

[3] Luz D., Berry, D. and Roos-Serote, M. : An automated method for tracking clouds in planetary atmospheres, New Astronomy, 13, pp. 224-232, 2008.

[4] Markiewicz, W. J. et al. : Morphology and dynamics of the upper cloud layer of Venus, Nature, 450, 633, 2007.

[5] Moissl, R. et al. : Venus cloud top winds from tracking UV features in Venus Monitoring Camera images, J. Geophys. Res., 114, E00B31, 2009.

[6] Piccioni, G. et al. : South-polar features on Venus similar to those near the north pole, Nature, 450, p. 637-640, 2007.

[7] Rossow, W. B., DelGenio A., and Eichler, T. : Cloud-tracked winds from Pioneer Venus OCPP images, J. At. Sci., 47, 2053, 1990.

[8] Sánchez-Lavega, A. et al. : Variable winds on Venus mapped in three dimensions, Geophys. Res. Letters, 35, L13204, 2008.

[9] Suomi, V. E. and Limaye, S. S. : Venus: Further evidence of vortex circulation, Science, 201, 1009, 1011, 1978.

[10] Taylor, F. W., McCleese, D. J. and Diner, D. J. : Polar clearing in the Venus clouds observed from the Pioneer Venus Orbiter. Nature 279, 613, 1979.