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Dynamics of Venus' southern polar vortex from over two years of VIRTIS/Venus Express observations

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Abstract

Recently, the results of an initial study of the southern polar region of Venus, using measurements from the VIRTIS instrument from the Venus Express Mission, revealed it to be in constant dynamic change, with the southern polar vortex displaced from the rotational geometry of the planet [1]. Here, we place these results in the context of measurements taken over a two year period.

We examine the dynamics of the southern polar region based on measurements of winds at the 45 and 65 km levels, detected from cloud motion monitoring by the VIRTIS instrument. The wind velocity components were determined by an automatic cloud-tracking technique based on evaluating the similarity between pairs of images of cloud structures at a specific atmospheric altitude, separated by a short time interval.

The images were obtained at infrared wavelengths of 1.74 and 2.3 μm, for the night side, and 3.9 and 5.0 μm, for both the day and night sides. These wavelengths are sensitive to radiation originating from levels close to the base and to the top of the cloud deck, respectively. The technique assumes that the clouds are passive tracers of the atmospheric mass flow, and that the cloud structure does not change substantially between the two images.

Our objectives have been 1) to provide horizontal maps of direct wind measurements at cloud tops and in the lower cloud level with a high spatial resolution; 2) to characterize the southern polar vortex as to its motion, rotation rate and dynamical stability; 3) to constrain the contribution of the circumpolar circulation to the angular momentum budget; and 4) to provide valuable information for Venus climate modelling, for the planning of future probe or balloon missions, and to examine the Venus polar vortex in the context of other planetary vortices.

The circulation in the southern polar region is dominated by the zonal flow, which is much stronger than the meridional circulation. The latitudinal profiles show a relatively smooth variation and the vertical shear between the 45-km and 65-km levels is on the order of 5–10 $\mathrm{m\,s^{-1}}$. The horizontal structure of the zonal and meridional wind components indicate that wavenumber-2 thermal tides are likely to be present.

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References

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