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Venus' South Polar Vortex morphology and dynamics from VIRTIS measurements during VEX mission

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Abstract

The VIRTIS instrument onboard VEX observes Venus in two channels (visible and infrared) obtaining spectra and multi-wavelength images of the planet. Here we present a study of the variable morphology of the South Polar Vortex [1], both in the upper and lower cloud levels, and a dynamical study based on measurements of the wind field in the vortex retrieved from cloud tracking over an ample set of images and wavelengths sensitive to different altitude levels. We present results from day-side images of the vortex obtained at 380 nm and 980 nm, both sensitive to two altitude levels within the upper cloud (66-70 km), night-side images in the near-infrared (1.74 μm) sensitive to the lower cloud (48 km), and from thermal infrared (3 – 5 μm) images sensitive to the cloud tops and able to study both the day and night-side of the planet [2]. We explore the different dynamics associated to the varying morphology of the vortex and the related time-scales.

1. Introduction

The data from the VIRTIS-M instrument allow to obtain images of Venus' atmosphere in particular observation windows that sample different layers of the atmosphere. In this work we have focused on high-resolution images of the South Polar Vortex on 3 wavelengths. At 1.74 microns, we see the thermal radiation from the lower atmosphere filtered by the deep cloud and at 3.80 and 5.10 microns we observe the thermal emission from the upper cloud. In the latter two cases, we get information about the same height-level but with different contrast and different capability to observe the polar day and night-side.

The Venus South Polar Vortex is a very dynamic atmospheric feature changing its appearance constantly (figure 1). In some cases these morphologies are stable over time for tens of days and in others we can observe fast changes in the morphology. In orbits which sample the vortex for several hours it is possible to see the slow variation of the cloud structures and measure the local wind fields [3].

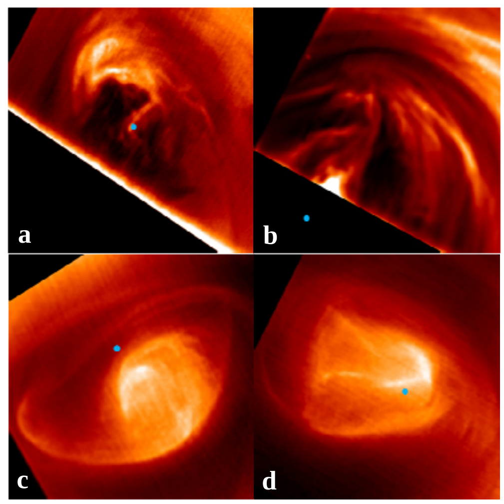

Figure 1: Images of the lower cloud at 1.74μm for (a) orbit 38 and (b) orbit 620. And the upper cloud at 5.10μm of (c) orbit 310 and (d) orbit 475.

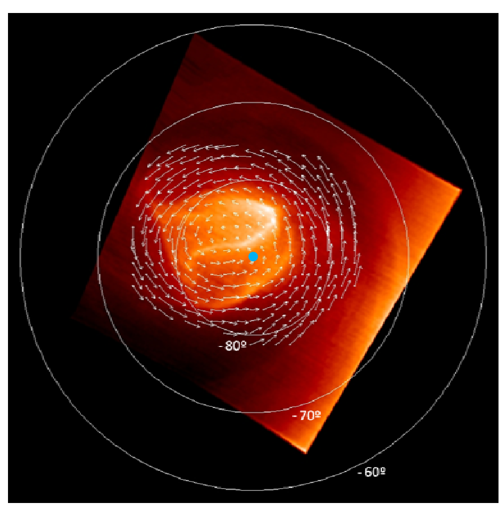

Figure 2: Wind field for orbit 475 at 5.10μm.

2. Wind Retrievals

2.1 Correlation Algorithm

To study the complex dynamics of the vortex we assume that the clouds drift with the local wind and we have used an image-correlator [4] to study the motions of these clouds. The program proposes the best region (the one which maximizes the correlation function between both images). Since the images are typically noisy we supervise all the measurements and we decide to apply or change this measurement looking at a spatial map of the correlation function, avoiding spurious measurements “on the fly”. An example is given in figure 2.

2.2 Profiles

We have a good polar coverage in the night and daysides for the upper cloud. For the deep cloud our data extends up to 20ºS. Considering a global view of all the wind maps we create, we detect oscillations in both components what means that the majority of our measurements are related with the local motions. The dispersion we get is real and not produced by measurement noise.

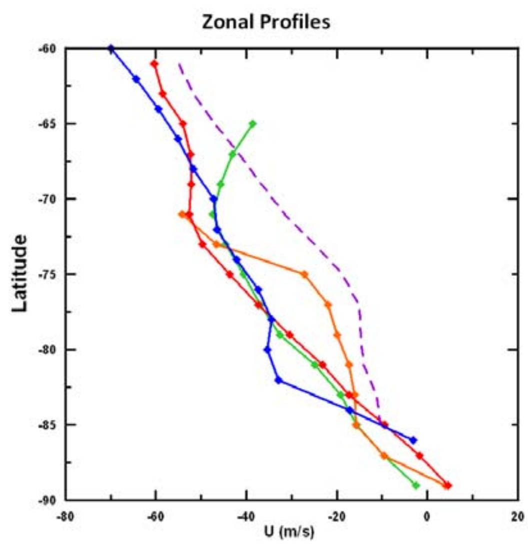

Figure 3: Zonal profiles of the wind field at 380nm (blue), 980nm (purple), 1.74µm (red), 3.80µm (orange) and 5.10µm (green).

The general pattern of the zonal component is maintained more or less in both vertical levels. The meridional component is always more chaotic than the zonal one (figure 3). As we gather more and more data we can explore other aspects of the global Southern hemisphere circulation such as the mean meridional motions and zonal winds variability.

3. Conclusions

The Venus polar vortex is a vertically coherent structure with low wind shear. However the dynamics at different layers are slightly different and seem to correlate with the observed morphology.

Globally the vortex rotates with the mean flow but individual structures in the vortex present their own motions which are correlated with the vortex morphology (single vortex, double vortex or more irregular vortex have different wind fields).

An analysis of the vortex motions with a much more extended number of orbits will be needed to explore the vortex variability and its role on the global dynamics.

Acknowledgements

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References

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