EPSC Abstracts
Vol. 6, EPSC-DPS2011-1230, 2011
EPSC-DPS Joint Meeting 2011

Global Cloud Organization and Motions on Venus from the Venus Monitoring Camera on Venus Express

S. Limaye (1), R.J. Krauss (1), D. Santek (1) and W. Markiewich (2)

(1) University of Wisconsin, Madison, Wisconsin USA, SanjayL@ssec.wisc.edu,/FAX: +1 608 262 5974)
(2) Max Planck Institute for Solar System Studies, Katlenbug-Lindau, Germany

Abstract

The Venus Monitoring Camera on Venus Express [1] has been collecting images of Venus from almost every orbit since operations began in June 2006. Five years of observations in four different filters reveal a dynamic global atmosphere but with the same basic vortex organization that changes on a time scale of days and months. Latitudinally averaged profiles of the large scale cloud features in the ultraviolet images show variations with time consistent with the changes seen in the vortex structure.

1. Introduction

Ultraviolet (365 central wavelength, 50 nm bandpass) images obtained from the VMC between orbits 24 and 1900 have been used to monitor the changes in the southern hemisphere of Venus. Although the VMC images Venus on almost every orbit, not all the images are suitable for complete analysis. This occurs when sufficient number of "on-orbit" flat field images are not available.

Images were processed and navigated at Deutsches Zentrum für Luft- und Raumfahrt (DLR) using SPICE kernels. The quality of the navigation was carefully monitored independently by measuring the limb locations in the images used and offsets between the best-fit image center and the SPICE derived center. On average, a small offset was found between the two centers averaged for all images used. In addition, a small correction to the pixel scale was also indicated.

For monitoring the hemispheric vortex organization, images were mapped into a polar stereographic projection. The cloud motions were determined from rectilinear maps of the images using digital cross-tracking method adapted from the operational tracking algorithm used at the University of Wisconsin for weather satellite images of Earth.

1.1 Vortex Organization

The global vortex organization of the Venus has been known since its discovery from Mariner 10 images [2]. Figure 1 below shows a space-time composite from images over three consecutive orbits. The component images were brightness normalized to remove the effects of the illumination and viewing geometry over the planet and rotated at the average rotation rate of the mid-high latitude regions of the atmosphere.

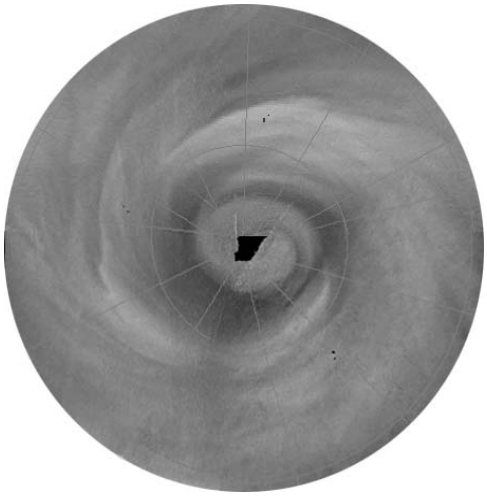

Figure 1. Space-time composite view of the southern hemisphere of Venus from VMC images taken through the ultraviolet (365 nm) filter. The south pole is at the center of the image and the outer periphery extends to about 15ºS.

A perfect match in the overlap regions is not always feasible given the off-center nature of the vortex and the meridional shear of the zonal flow, but the com-

posite nevertheless provides a good qualitative indication of the vortex in terms of the location of the spiral bands and the convergence zone believed to be indicated by the dark collar, almost coincident with the colder (and higher) regions of the Venus cloudtop seen at the ultraviolet region of the solar spectrum

2. Global Circulation

Figure 2 shows a comparison of average meridional profiles of the zonal component of motion of the large scale ultraviolet cloud motions between orbits 1182-1189 and 1108-1110. The smooth curves represent polynomial fits. At latitudes poleward of about 60º the number of suitable (trackable) features in the ultraviolet images decreases substantially. The data points represent latitude bin average values and the error bars represent one standard deviation of the bin average value.

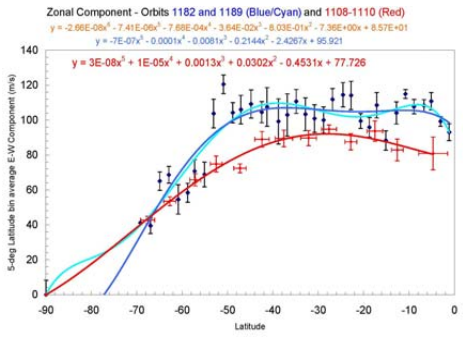

Figure 2. Comparison of two meridional profiles of large scale cloud motions averaged over orbits 1108-1110 and 1182 - 1180. The differences observed are typical of the short term variations seen on Venus historically.

The spatial resolution of the VMC images and the Venus Express orbit together mask the higher resolution structure of the Venus circulation and hence the measured cloud motions are only indicative of the global circulation but not definitive. The wide field of view (~ 20º) provides a global view of the dayside hemisphere of Venus from near apoapsis at ~ 45 km/pixel scale, necessitating at least an hour separation between successive images used for tracking, resulting in a measurement limit of ~ 12 ms^{-1}. Images acquired closer to the planet have a higher precision, but provide limited spatial coverage and require corrections to pointing.

Acknowledgements

This work was supported by a NASA Participating Scientist Grant (NNX09AE85G) and by the support provided to the VMC team in Germany.

References

[1] Markiewicz, W.J., D.V. Titov, N. Ignatiev, H.U. Keller, D. Crisp, S.S. Limaye, R. Jaumann, R. Moissl, N. Thomas, L. Esposito, S. Watanabe, B. Fiethe, T. Behnke, I. Szemerey, H. Michalik, H. Perplies, M. Wedemeier, I. Sebastian, W. Boogaerts, S.F. Hviid, C. Dierker, B. Osterloh, W. Boeker, M. Koch, H. Michaelis, D. Belyaev, A. Dannenberg, M. Tschimmel, P. Russo, T. Roatsch and K.D. Matz. Venus Monitoring Camera for Venus Express, Planet. Space Sci. 55, n12, 1701-1711, 2007.

[2] Limaye, S.S., J.P. Kossin, C. Rozoff, G. Piccioni, D. Titov, and W. J. Markiewicz, 2009. Vortex circulation on Venus: Dynamical similarities with terrestrial hurricanes, Geophys. Res. Lett., 36, L04204,doi.:10.1029/2008GL036093, 2009.

.

[3] Moissl, R., I. Khatuntsev, S.S. Limaye, D.V.Titov, W.J. Markiewicz, N.I. Ignatiev, T. Roatsch, K.-D. Matz, R. Jaumann, M. Almeida, G. Portyankina, T. Behnke, S.F Hviid. Venus cloud top winds from tracking UV features in Venus monitoring Camera images, J. Geophys. Res. 114, E00B31, doi:10.1029/2008JE003117, 2009.

[4] Velden, C., C. M. Hayden, S. J. Nieman, W. P. Menzel, S. Wanzong, and J. S. Goerss, 1997: Upper-tropospheric winds derived from Geostationary satellite water vapor observations. *Bull. Amer. Meteor. Soc.*, **78,** 173-195.

.