EPSC Abstracts
Vol. 9, EPSC2014-655, 2014
European Planetary Science Congress 2014

Temporal Variations observed in the Cloud Cover of Venus from Venus Monitoring Camera

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Abstract

The Venus Monitoring Camera (VMC) on Venus Express [1] has been collecting images of the planet since orbit insertion in April 2006 through four narrow band pass (50 nm halfwidth) with center wavelengths of 365, 550, 950 and 1050 nm [2]. With varying range to the planet during the spacecraft's elliptical, near polar orbit, VMC obtains views of the day side southern hemisphere (~ 72,500 km) and the limb when it is furthest away from the planet, and can see a fraction of the planet's sun-lit limb northern latitudes when the spacecraft is closer to the planet (>~ 25,000 km). We use these images to look at the temporal behavior of the normalized intensity and unit slant optical depth (location of the bright limb) at four wavelengths during April 2006 – March 2014. We detect correlated changes in the normalized brightness and the altitude of the unit optical depth over this period.

1. Introduction

Venus Express mission is contributing a lot to our knowledge of the global cloud cover on Venus comprosing of a thick cloud layer blended with prevalence of haze. Pioneer Venus Orbiter mission observed the dynamic behavior of this mix in both low resolution polarization (> ~ 100 km per pixel) and imaging observations (>~ 25 km per pixel) from the Orbiter Cloud Photopolarimeter (OCPP) which used spin scan imaging technique, first pioneered for Earth observation from geosynchronous orbit. Venus Express improves upon the Pioneer Venus imaging data to some degree with a longer observation period, more extensive imaging using a CCD sensor for the VMC. Unfortunately, the VMC suffered significant damage through prolonged exposure to direct Sun, which affected its performance post orbit insertion [3].

Nevertheless, VMC has provided tens of thousands of images (figure 1) at four wavelengths which depict the evolution of the global cloud/haze cover over the mission.

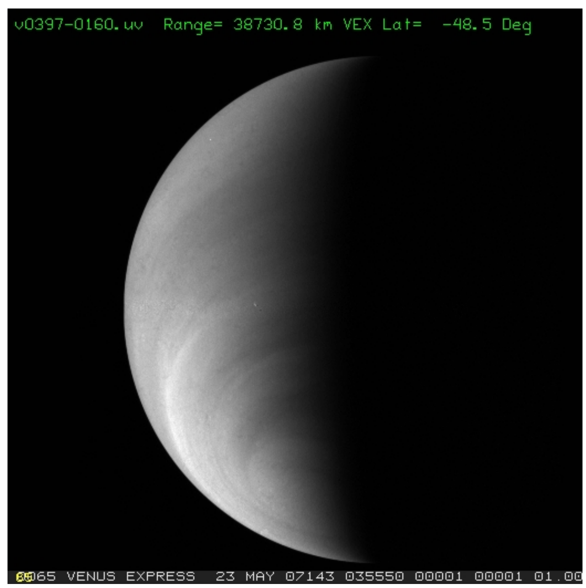

Figure 1. An image taken through the UV filter by VMC on orbit 397

2. Albedo Evolution Over Time

One quantitative means of detecting the change is monitoring the normalized brightness by correcting for the scattering geometry using a scattering law, such as Minnaert law to discern changes in the cloud properties over the long term:

$$I = I_0 (\mu\mu_0)^k$$

where, I is the observed intensity, $I_{0\ can}$ be thought of as the albedo, μ and μ_0 represent cosines of the viewing and solar zenith angles, and k is a constant. We By using the image geometry, we determined the Minneart coefficients I_0 and k by least squares for each image, and produced new versions of images depicting the albedo variations. By examining the collection of such normalized images over the duration of the mission, we can discern some patterns which are consistent at all four wavelengths. Figure 2 shows a normalized version of the image shown in Figure 1.

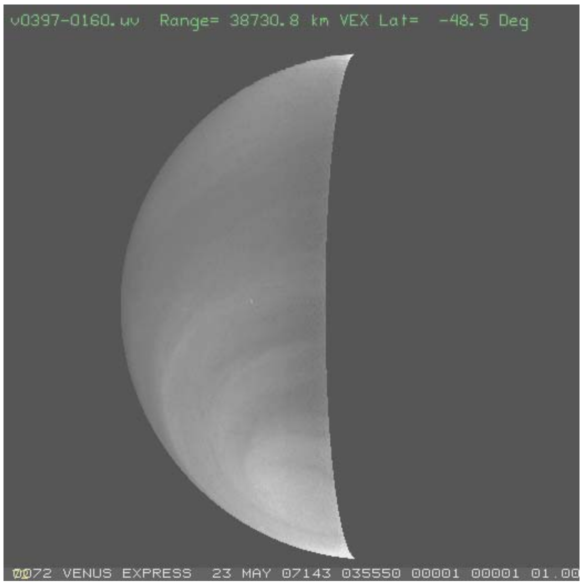

Figure 2. Brightness normalized version of the image.

3. Unit Optical Depth Over Time

Another quantity that we can examine from the collection of images is the level of the unit optical depth, which is determined by searching for the maximum radial brightness gradient, corresponding to the limb or the “edge” of the planet seen on the day side. By determining the location of the limb as a function of the local solar time, we can obtain a time series of its distance from the planet center over time [4] at all four wavelengths.

We observe significant changes in the level of the unit optical depth over nearly eight years of the imaging observations, many at all four wavelengths. These results will be presented in greater detail.

Acknowledgements

This work was supported by NASA Grant NNX09AE85G.

References

[1] H. Svedhem,D.V. Titov, F.W. Taylor, O. Witasse, The Venus Express mission, *Nature* 450, 629–632, 2007.

[2] Markiewicz, W. J. *et al.* Venus monitoring camera for Venus Express. Planet. Space Sci. 55, 1701–1711, 2007.

[3] Titov, D.V., W.J. Markiewicz, N.I. Ignatiev, L.Song, S.S. Limaye, A. Sanchez-Lavega, J. Hesemann, M. Almeida, T. Roatsch, K.-D. Matz, K-D., F. Scholten, D. Crisp, D., L.W. Esposito, S.F. Hviid, R. Jaumann, H.U. Keller, and R. Moissl, Morphology of the cloud tops as observed by the Venus Express Monitoring Camera, Icarus, 217, 682-701, 2012.

[4] Limaye, S.S., W.J. Markiewicz, R.J. Krauss, N. Ignatiev, T. Roatsch, K.-D. Matz, Focal Lengths of Venus Monitoring Cameras from Limb Locations, submitted to Planetary and Space Science, 2014.