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Ultraviolet albedo of Venus' clouds due to SPICAV and VIRTIS joint nadir observations onboard Venus Express

Pavel Vlasov (1), Emiliano D'Aversa (2), Denis Belyaev (1), Nikolay Ignatiev (1), Jean-Loup Bertaux (1, 3), Emmanuel Marcq (3), Lucio Baggio (3), Giuseppe Piccioni (2) and Robert Carlson (4)
(1) Space Research Institute (IKI), Moscow, Russia, (2) INAF-IAPS, Roma, Italy, (3) LATMOS-CNRS, Guyancourt, France, (4) CalTech JPL, Pasadena, California USA (pavel.vlasov@phystech.edu)

Introduction

Venus' clouds look very bright and homogeneous in the visible spectral range due to high spherical albedo around 70-80%. However, the clouds appear to be 2-3 times less bright and much contrasted in the ultraviolet (UV) region. Dark spots in the UV images point out to presence of some components in the atmosphere that absorb solar radiation at wavelengths from 200 to 400 nm, and it may affect on the thermal balance of the planet. In addition to well-known molecules, like sulfur dioxide (SO_2) [1, 2], there are some candidates for unknown UV absorbers: cyclo-octal S_8 and polymeric sulfur S_x with different valences [3], OSSO [4], Cl_2 [5] and $FeCl_3$ [6]. Despite numerous researches, so far, there was no complete albedo spectrum continuously measured in the range of 200-600 nm to precisely interpret chemical composition of the unknown UV absorbers of Venus clouds.

In this paper we present initial results of the nadir data processing from two spectrometers that measured UV albedo of Venus clouds onboard the Venus Express (VEX) orbiter in 2006-2014. The UV channel of SPICAV operated in the range of 115-320 nm [7], while the UV-VIS channel of VIRTIS covered the range of 300-1000 nm [8]. We have selected a few tens of simultaneous nadir observations of Venus clouds with similar pointing that allows us combining the clouds reflectance spectra at 200-600 nm using datasets from two spectrometers.

Data description

We estimate albedo at the nadir viewing as a ratio of the measured absolute radiance to the solar irradiance at Venus due to the cosine of the solar zenith angle. At the moment, only SPICAV data are completely calibrated while VIRTIS spectra require some processing. The main problem is to subtract the contamination of absolute radiance spectra in the range of 300-500 nm. There is a parasitic light that is most likely caused by reflected solar irradiance sent from the external zone (IR-channel) into the central zone (VIS-channel) of the VIRTIS grating [9]. It was possible to partially subtract this stray light from the spectra, using calibration measurements of the Moon reflectance during the spacecraft cruise. After that, we made a wavelength correction of spectra using solar lines from Kurucz database [10]. It turned out that the linear law is enough for the pixel to wavelength assignment. An example of combined absolute radiance spectra in the range of 200-600 nm for one set of observations (orbit 110) is presented in Figure 1(a).

In order to estimate the albedo by VIRTIS we used the "nodes" method that allowed us to get rid of the dependence on the spectral resolution, which is not defined precisely in the range of 300-600 nm. According to the "nodes" method, an albedo spectrum is calculated being convolved with several spectral resolutions, varying from 2 to 8 nm. Resulted spectrum is taken at invariant points. An example of combined UV albedo spectra in the range of 200-600 nm for one set of observations (orbit 110) is presented in Figure 1(b).

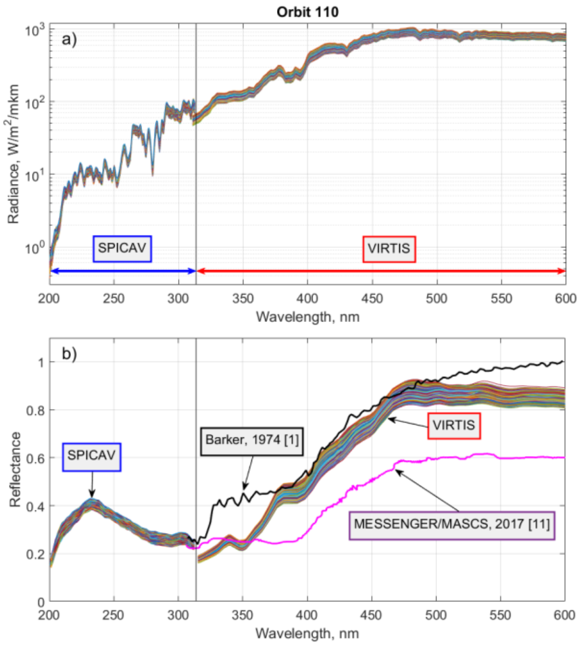

Figure 1: An example of one set of observations in the range of 200-600 nm. Orbit 110, 9 Aug 2006, latitude range: 5-31º, local time range: 10.3567-10.3644. (a): SPICAV and VIRTIS combined absolute radiance spectra. (b): SPICAV and VIRTIS combined UV albedo spectra. To compare, Barker's ground observations in 1974 (in black) [1] and MESSENGER/MASCS observations in 2017 (in pink) [11].

It is clearly seen from Figure 1(b) that the parasitic stray light subtraction is not very accurate because of overcorrection in the range of 300-370 nm. This didn't allow us to obtain continuous combined UV albedo spectra, so the work of subtracting light in a correct way is still ongoing. Comparing the results with Barker's ground-based observations of Venus in 1974 [1] and MESSENGER/MASCS observations in 2017 [11] shows up that the shape of our albedo spectra is a bit different from the other spectra what is the subject of additional consideration. Solving these problems will help us to obtain continuous spectra and using them to determine the unknown ultraviolet absorbers in Venus clouds and retrieve their contents in the atmosphere.

Acknowledgements

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References

[1] Barker E.S. Relative Spectrophotometry of Venus from 3067 to 5960 Å. Journal of the Atmospheric Sciences. – 1975. – Vol.32. – P. 1205-1211

[2] Marcq E. et al. Variations of sulphur dioxide at the cloud top of Venus's dynamic atmosphere. Nature Geoscience. – 2013. – Vol.6. – P. 25-28

[3] Carlson R. W. et al. Venus's ultraviolet absorber: Cyclo-octal (S_8) and polymeric sulfur (S_x) and their latitudinal behavior. International Venus Conference, Oxford, 2016

[4] Frandsen B. N. et al. Identification of OSSO as a near-UV absorber in the Venusian atmosphere. Geophys. Res. Lett. – 2016. – Vol.43. – P. 11146–11155

[5] Pollack J.B. et al. Distribution and source of the UV absorption in Venus atmosphere. J. Geophys. Res. – 1980. – Vol.85. – P. 8141–8150

[6] Zasova L.V. et al. Vertical distribution of SO_2 in upper cloud layer of Venus and origin of UV-absorption. Advances in Space Research. – 1981. – Vol.1. – P. 13-16

[7] Bertaux J.-L. et al. SPICAV on Venus Express: Three spectrometers to study the global structure and composition of the Venus atmosphere. Planet. Space Sci. – 2007. – Vol.55. – P. 1673–1700

[8] Drossart P. et al. Scientific goals for the observation of Venus by VIRTIS on ESA/Venus express mission. Planet. Space Sci. – 2007. – Vol.55. – P. 1653-1672

[9] Coradini A. et al. VIRTIS: An imaging spectrometer for the Rosetta mission. Space Science Reviews. – 2007. – Vol.128. – P. 529-559

[10] Kurucz, R.L., 1997. The solar irradiance by computation. http://kurucz.harvard.edu/sun/irradiance/solarirr.tab

[11] Pérez-Hoyos et al. Venus upper clouds and the UV absorber from MESSENGER/MASCS observations. J. Geophys. Res. – 2018. – Vol.123(1). – P. 145-162