Venus Express observations during the 2012 Venus transit

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Abstract: *The Venus transit which occurred on 6 June 2012 is the first which occurred while a spacecraft was in orbit around Venus. The European Space Agency's Venus Express satellite, which has been in orbit around Venus since April 2006, observed Venus during the transit to provide space-based observation to compare with ground-based observations of Venus during the transit.*

In this poster we report the successful observations from the SPICAV-UV, SPICAV-SOIR, and VIRTIS and instruments; unfortunately, due to a technical problem, the VMC camera did not operate as planned during the transit.

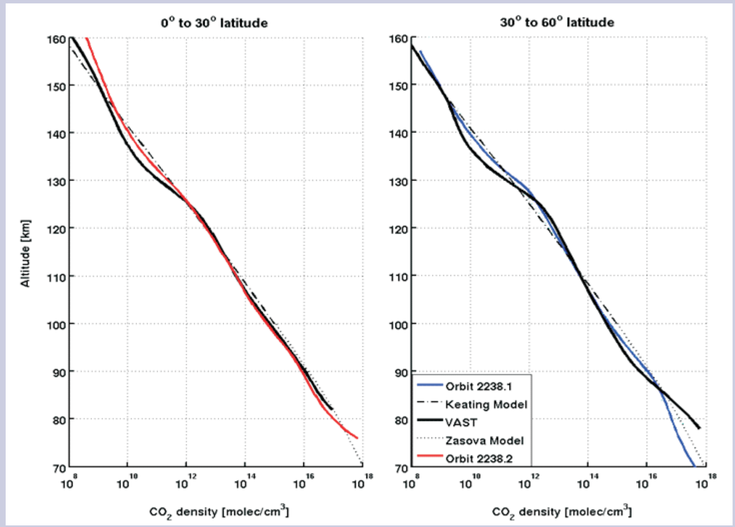


Figure 1: CO_2 density profiles of Orbits 2238.1 (right) and 2238.2 (left) that occurred during the Venus transit of 6th of June 2012. The density profiles are given as a function of the altitude. The black lines are the density profiles from VAST for the 0° to 30° latitude range (left) and for the 30° to 60° latitude range (right). Errors are included within the thickness of the lines.

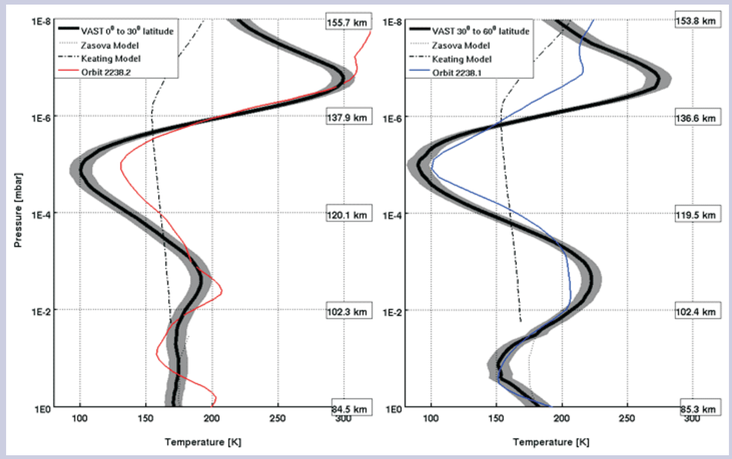


Figure 2: CO_2 temperature profiles (right) of Orbits 2238.1 and 2238.2 that occurred during the Venus transit of 6th of June 2012. The temperature profiles are given as a function of the total pressure, with the altitude given on the right side as an indication. The black lines are temperature profiles from VAST for the 0° to 30° latitude range (left) and for the 30° to 60° latitude range (right). The gray envelope is its confidence range.

Solar Occultation (SOIR) observations

The SOIR instrument (Solar Occultation in the InfraRed) is one of the three channels of the SPICAV/SOIR instrument onboard VEX [1]. It is an infrared spectrometer covering the 2200 to 4400 cm^{-1} region. SOIR took benefit of another Venus transit, not the one seen from Earth, but from the VEX spacecraft itself. Observations were made both during the ingress (latitude 50°N, denoted as 2238.1 in the figures below) and at egress (latitude 30°N, denoted below as 2238.2), at 3:30 - 4:00 UTC, during the Venus transit as seen from Earth. SOIR recorded transmission spectra on the whole altitude range, from which CO_2 density and temperature profiles (Figs 1 & 2) and aerosol vertical distribution (Fig. 3) has been investigated and are presented here.

In Figures 1 and 2, CO_2 density and temperature profiles recorded during the Venus transit (Orbits 2238.1 and 2238.2) are compared to VAST (Venus Atmosphere from SOIR measurements at the Terminator) described in [2]. The profiles observed in Orbits 2238.1, 2238.2 differ from the VAST profils, but this level of variability is within the normal range of variability observed by SOIR, and is also consistent with levels of thermospheric density variations observed by the Vex atmospheric drag experiment [4].

The continuum of absorption in the SOIR spectra is primarily shaped by the extinction caused by the aerosol particles present in the upper haze (between ~70 and 100 km) of the Venus mesosphere. This information allows retrieval of the local extinction due to aerosols as described in [3]. For both Orbits 2238.1 and 2238.2, the aerosol vertical distribution is similar to those of Orbits 443.2 and 884.2 at comparable mid-latitude comprised between 30 and 60°N (see inset on Fig. 3), while the profiles is shifted towards lower values of the local extinction for orbits 143.1, 357.1 and 697.1 at latitude higher than 60°N. This in line with the latitudinal dependency of the extinction emphasized from the analysis of 4 years of SOIR measurement [3].

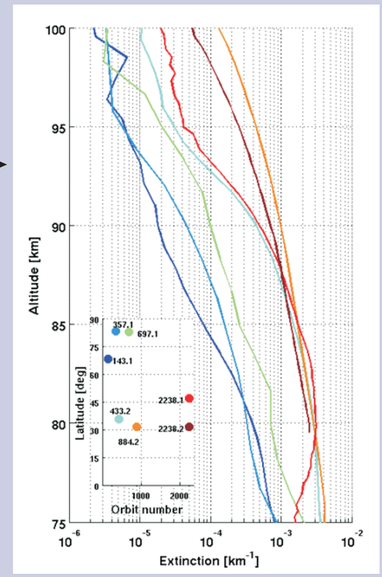


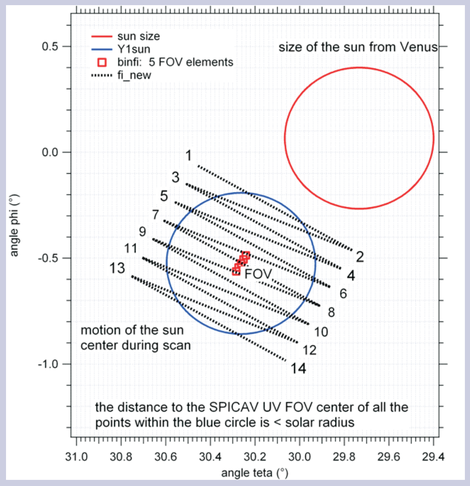
Figure 3: Extinction vertical profiles are plotted for a number of typical SOIR observations. The inset panel gives the measurement latitude and the orbit number. Brown and red profiles are derived from measurements during the Venus transit of 6th of June 2012. For clarity, error bars are not plotted, the error is ~15% of the value of the local extinction.

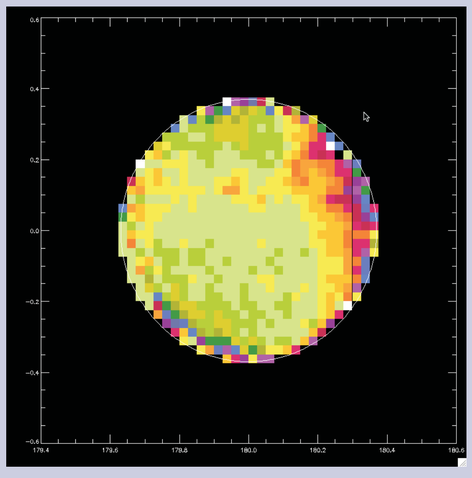
References
[1] Nevejans et al.: Applied Optics, Vol. 45(21), pp. 5191-5206, 2006.
[2] Mahieux et al.: J. Geophys. Res, Vol. 117, E07001, doi:10.1029/2012JE004058, 2012.
[3] Wilquet et al. : Icarus, 217, pp. 875–881, 2012.
[4] Rosenblatt et al. : EPSC Abstracts Vol. 7 EPSC2012-316, 2012.

SPICAV solar scans

The SPICAV spectrometer suite conducted UV hyperspectral imaging of the Sun with a spatial resolution of about 2 arcmin (the sun is 40 arcmin in diameter as seen from Venus). The resulting data is a hyperspectral image, a cube composed of about 100 maps at all wavelengths between 190 and 310 nm with a spectral resolution of 1.5 nm.

These solar observations are now carried out regularly (~fortnightly) throughout the mission, but the Venus transit offered a unique opportunity to cross-calibrate these observations with many ground-based (or near-Earth) observatories such as the SOLSPEC solar spectrometer on the ISS.



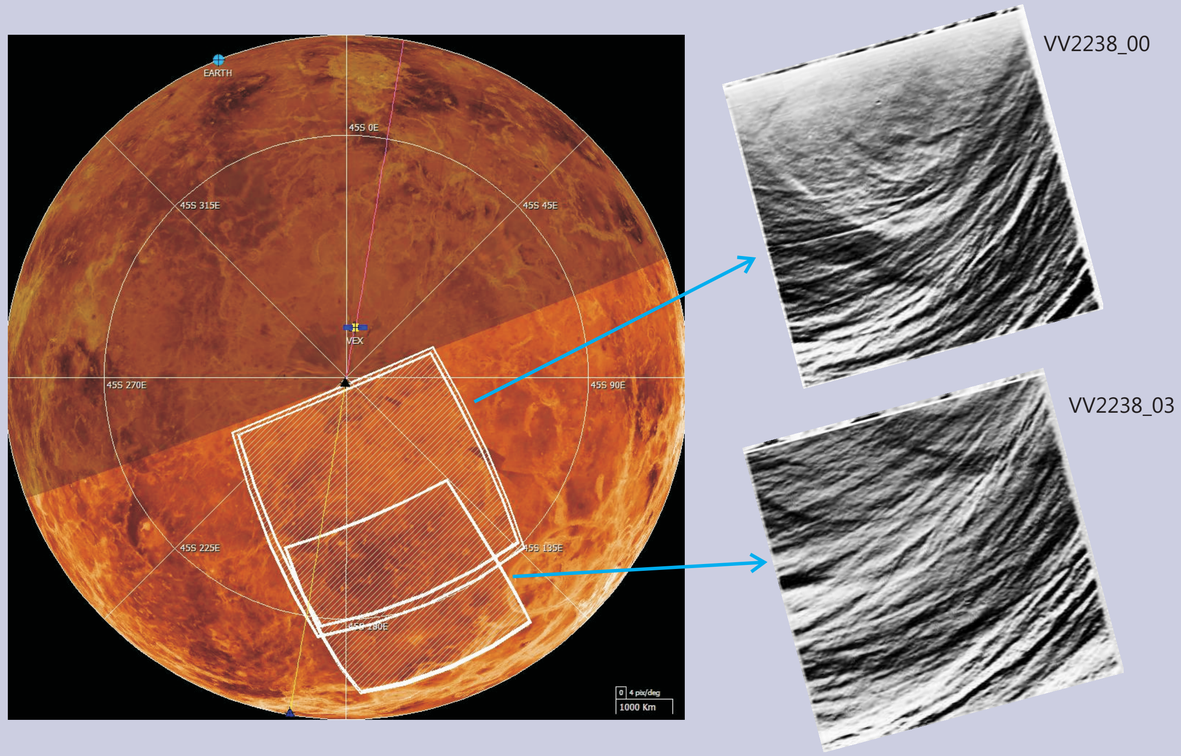


The figures here show (left) Spacecraft pointing sequence for sun scan acquisition, and (right) Sun scan from orbit 2122 (11 Feb 2012 – results from June 2012 have not yet been processed). The figure shows mean UV radiance in the range 200-300 nm, divided by a limb darkening correction factor. A region of solar activity can clearly be seen above the centre of the solar disc.

VIRTIS spectral imaging

The VIRTIS imaging spectrometer obtained hyperspectral images in a wavelength range from 280 - 1050 nm, of high Southern latitudes on the dayside of Venus. Pairs of images were obtained at 1 hr intervals in order to permit cloud-top wind velocity determination from cloud tracking.
The data will allow constraint on the position of the polar vortex during the transit; also, cloud-tracking analysis will reveal the level of circumpolar jets at cloud-top level at this time.

DATA ID	Start_Time
VV2238_00	19:40 05/06/12
VV2238_01	20:26 05/06/12
VV2238_02	21:27 05/06/12
VV2238_03	22:37 05/06/12



The left-hand figure show the location of VIRTIS-M-VIS observations in the hours just before the transit On the right are shown two of the four acquisitions; the images were acquired in the UV (summation of bands 383 - 402 nm) and have had a high-pass spatial filter applied to reveal cloud-level contrast.