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Assessing near-surface radiance levels based on VIRTIS spectra to prepare VenSpec-H science

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In the frame of the preparation of the EnVision mission, going back to existing datasets is essential. In this investigation, the 1.17 µm band both of interest for VenSpec-M and VenSpec-H is analysed from a statistical point of view based on the calibrated dataset provided in Mueller et al. (2020) [1]. The radiative transfer model, ASIMUT-ALVL [2], is then validated against these averaged observations.

VenSpec-H is part of the VenSpec suite [3], also including an IR mapper and a UV spectrometer [4]. The suite science objectives are to search for temporal variations in surface temperatures and tropospheric concentrations of volcanically emitted gases, indicative of volcanic eruptions; and to study surface-atmosphere interactions. Maintenance of the clouds requires a constant input of H_2O and SO_2. A large eruption would locally alter the composition by increasing abundances of H_2O, SO_2, and CO and possibly decreasing the D/H ratio. Observations of changes in lower atmospheric SO_2, CO, and H_2O vapour levels, cloud level H_2SO_4 droplet concentration, and mesospheric SO_2, are therefore required to link specific volcanic events with past and ongoing observations of the variable and dynamic mesosphere, to understand both the importance of volatiles in volcanic activity on Venus and their effect on cloud maintenance and dynamics. VenSpec-H's main scientific objectives are (1) to better constrain the composition of the atmosphere both below and above the clouds to relate changes in the composition to changes on the surface or geological processes such as volcanism; (2) to investigate short and long-term trends in the composition to better grasp the climate evolution on Venus.

VenSpec-H is designed to measure H_2O, HDO, CO, OCS, and SO_2 on both the night and day side to contribute to this investigation. VenSpec-H is a nadir-pointing, high-resolution (R~8000) infrared spectrometer that will perform observations in different spectral windows between 1 and 2.5 µm. Spectra in these bands will be recorded sequentially with the help of a filter wheel and will allow the sounding of different layers in the Venusian atmosphere: close to the surface (1.17 µm), 15-30 km (1.7 µm), 30-40 km (2.4 µm) and above the clouds (1.38 & 2.4 µm). Two additional polarization filters will be used during dayside observations to better characterize the clouds' properties.

VIRTIS was an instrument with three different channels, mapping visible (M-VIS), mapping infrared

(M-IR) and high-resolution infrared (H). It flew onboard Venus Express from 2006 to 2014 and delivered major science results [5-7].

We consider the M-IR channel which was a line scanning imaging spectrometer observing in the near infrared from approximately 1 μm to 5 μm. Having acquired about 5000 data cubes, VIRTIS-M-IR stopped measuring science data in October 2008 when its cryocooler failed.

This investigation is based on calibrated data covering the spectral range from 1020 nm to 1400 nm (bands 0 to 39) with a spectral sampling of 9.5 nm and published in 2020. This dataset has been calibrated to include the 1 to 1.4 μm with Even-Odd correction and sun straylight subtraction [1]. It was also spectrally calibrated based on Cardesin Moinelo et al., 2010 [8].

A statistical analysis of the VIRTIS-M-IR dataset was performed, considering account millions of spectra, In the frame of the scientific preparation of EnVision, we focused on the 1.17 μm band which is common to VenSpec-H and VenSpec-M. Averaged spectra were calculated by considering latitudinal and temporal binning. Outliers were identified for further analysis.

The BIRA-IASB radiative transfer code, ASIMUT-ALVL [2], has been used as a forward modeling tool in this spectral range to make sure all contributions were properly understood. The radiances of the nightside atmosphere of Venus originate from the thermal emission of the surface and atmosphere. The impacts of the molecular species (line-by-line and collision induced absorption) and of the aerosols were analyzed separately to, in fine, reproduce the VIRTIS-M-IR calibrated observations.

This investigation has been led to characterise the radiance levels that VenSpec-H will likely observe when measuring the variations of the minor species in Venus' troposphere. In this presentation, we will discuss the data analysis and its impact on the expected performances of our future instrument.

References

[1] N.T. Mueller et al., "Multispectral surface emissivity from VIRTIS on Venus Express", Icarus, 335 (2020) 113400.

[2] A.C. Vandaele, M. Kruglanski and M. De Mazière, "Modeling and retrieval of atmospheric spectra using ASIMUT", *Proc. of the First 'Atmospheric Science Conference'*, ESRIN, Frascati, Italy, 2006.

[3] J. Helbert et al., "The VenSpec suite on the ESA EnVision mission to Venus", *Proc. SPIE 11128, Infrared Remote Sensing and Instrumentation XXVII*, (2019) 1112804.

[4] E. Marcq et al., "Instrumental requirements for the study of Venus' cloud top using the UV imaging spectrometer VeSUV", *Advances in Space Research*, 68 (2021) 275-291.

[5] Piccioni, G. et al., "South-polar features on Venus similar to those near the north pole", Nature, 450 (7170) (2007) 637-640.

[6] Drossart, P. et al., "A dynamic upper atmosphere of Venus as revealed by VIRTIS on Venus Express", Nature, 450 (7170) (2007) 641-645.

[7] E. Marcq et al., "Minor species in Venus' night side troposphere as observed by VIRTIS-H/Venus Express", *Icarus*, 405 (2023) 115714.

[8] A. Cardesin Moinelo, et al., "Calibration of hyperspectral imaging data: VIRTIS-M Onboard Venus Express " IEEE Transactions on Geoscience and Remote Sensing, 48(11) (2010) 3941-3950.