Constraints on the Venusian lower cloud using VIRTIS-M-IR

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Near-infrared spectra from the Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) on Venus Express provide the opportunity for investigating a wide range of Venusian atmospheric parameters. The sulphuric acid clouds are of particular interest, since they significantly affect the radiative budget of the planet on a range of spatial scales, yet they are not well-understood. Determination of gaseous abundances by comparison of radiative transfer model spectra with observed spectra is heavily dependent on the representation of the cloud in the model, so understanding of the cloud structure is crucial for the study of the Venusian lower atmosphere.

VIRTIS-M-IR, the infrared section of the VIRTIS mapping specrometer, is used in this work. Models were produced using the NEMESIS radiative transfer and retrieval code (Irwin et al., 2008)[1]. The spectral window regions covered by VIRTIS-M-IR is sensitive on the nightside of the planet to absorption by the lower and middle cloud layers, which are back-lit by radiation from the the hot lower atmosphere and surface. Variable input quantities in the cloud model apart from the total lower cloud optical depth are the concentration of the acid in the clouds, the average size of the particles (altered by varying the relative abundances of the mode 2′ and larger mode 3 particles) and the vertical distribution of the cloud (parameterised by varying the altitude of the cloud base). The sensitivity to these variables across the VIRTISM-IR spectral range can be explored by comparing radiances at pairs of wavelengths in model branch plots and thereby defining a parameter space sensitive to one or more of these variables. Using multiple branch plots allows the variation due to each of these variables to be independently characterised. The position of each data point in such a parameter space can then be used to infer values for acid concentration, abundance of mode 3 particles and cloud base altitude.

This technique allows the spatial variation of sulphuric acid concentration in the cloud particles to be estimated for the first time. Since the shape of the infrared spectrum is heavily dependent on the acid concentration, constraining the concentration is a crucial first step in the determination of other cloud properties and gaseous abundances by remote sounding techniques.

References

[1] Irwin, P. G. J., N. A. Teanby, R. de Kok, L. N. Fletcher, C. J. A. Howett, C. C. C. Tsang, C. F. Wilson, S. B. Calcutt, C. A. Nixon, and P. D. Parrish (2008), The NEMESIS planetary atmosphere radiative transfer and retrieval tool, J. Quant. Spectrosc. Radiat. Transf., 109, 1136—1150