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Determining vertical cloud structure on Venus using near-infrared spectroscopy

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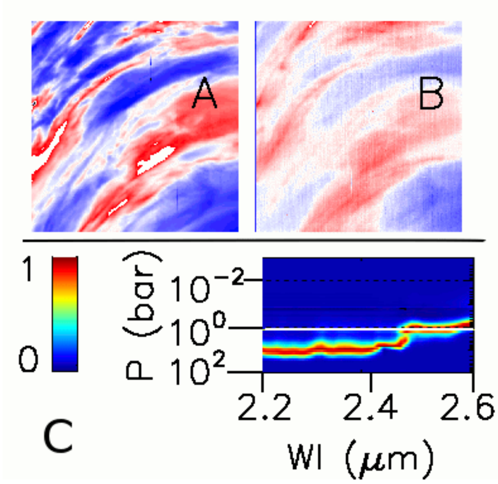
Abstract

Near-infrared spectra from the Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) on Venus Express provide the opportunity for investigating and constraining a wide range of atmospheric parameters for Venus. A small peak between 2.5 and 2.6 microns has been recently discovered in VIRTIS nightside spectra, and is shown by radiative transfer modelling to be sensitive to variations in both cloud base altitude and water vapour abundance within the cloud layer. If the H_2O abundance can be constrained, it may be possible to retrieve the cloud base altitude directly from VIRTIS-M spectral data. If these retrievals can be successfully validated they should provide valuable insight into dynamical processes on Venus.

Method

VIRTIS seeks to exploit the series of atmospheric 'windows' in the infrared for which the atmosphere of Venus is transparent. Nightside observations of Venus by Allen and Crawford (1984) resulted in the discovery of high radiance peaks corresponding to windows centred at 1.74 and 2.3 µ m. Both are sensitive to properties of the concentrated H_2SO_4 clouds which exist between altitudes of ~48 and 80 km, covering most of the planet. Smaller peaks between 2.3 and 2.5 µ m are sensitive to gaseous abundances.

A new cloud parameterisation has been developed for the NEMESIS planetary atmosphere radiative transfer and retrieval tool (Irwin et al., 2007) which may be used to retrieve cloud base altitude. Retrievals between 2.18 and 2.3 µ m wavelength are used to first constrain the integrated number density of cloud aerosol particles. The result is carried forward to a second retrieval in the range 2.3–2.6 µ m which constrains simultaneously abundances of CO, water vapour and OCS, and cloud base altitude.



A) 2.3 µ m image from VIRTIS observation VI0319_00, indicating cloud cover. Red corresponds to bright pixels and blue to dark. B) 2.53 µ m image of the same observation. C) Modelled normalised change in spectral radiance per 1K increase in temperature at a given altitude. White line marks the approximate cloud base. Altitude of maximum sensitivity increases with wavelength.

References

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