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Retrieval of surface emissivity from VIRTIS/VEX radiation measurements over the Northern hemisphere of Venus

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The radiation measurements of VIRTIS-M-IR (1-5 μm) on Venus Express provide a valuable database for systematic studies of the atmosphere and surface of Venus. The high variability of nightside atmospheric and surface emission window radiances with respect to cloud opacity and surface elevation is modeled and discussed in comparison with measurements performed over the Northern hemisphere.

The radiative transfer simulations for a quantitative evaluation of atmospheric and surface parameters use the DISORT code and include absorption, emission, and multiple scattering by atmospheric gaseous and particulate constituents. Look-up tables of quasi-monochromatic absorption cross-sections of gaseous constituents are calculated on the basis of a line-by-line procedure that makes use of appropriate spectral line databases. Microphysical parameters of the four-mode H2SO4 clouds are calculated from Mie theory. Deep atmospheric window continuum absorption is estimated from simultaneous retrievals of many spectra that were recorded for a high variety of atmospheric and surface conditions.

Due to the conservative scattering behavior of the clouds below 1.5 μm, radiance ratios of the emission windows, which are located between 1.10 and 1.35 μm, and the most topography sensitive window at 1.02 μm may serve to de-cloud the measurement data and yield a quick-look tool to extract the surface elevation. While the ratio-based VIRTIS topography is in good agreement with Magellan topography for most swaths, some differences occur in localized areas. Possible origins of such anomalies are discussed. They can be due to local surface or near surface temperature fluctuations, local unstable atmospheric dynamics, or still unknown spectral cloud features. Some of the predicted anomaly candidates were found to originate from measurement or calibration uncertainties, but some other point to variations of surface emissivity. Such variations are due to changes in the chemical composition (mineralogy) and/or surface texture. They are therefore important indicators of the nature of the surface material.

Radiance retrievals along a number of complete Northern orbits reveal systematic trends towards lower values of highland surface emissivity compared with surrounding lowlands. This result is in accordance with increased Magellan radar reflectivities at high altitudes and supports the hypothesis of older highland regions with felsic rock components.