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VEM on VERITAS - Retrieval of global infrared surface emissivity maps of Venus and expectable retrieval uncertainties

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Even though Venus is in many respects the most Earth-like planet we know today, its surface composition and geology are not well understood yet. The major obstacle is the extremely dense, hot, and opaque atmosphere that complicates both *in situ* measurements and infrared remote sensing, the wavelength range of the latter often being the range of choice due to its coverage of many spectral properties diagnostic to the surface material's composition and texture. Thermal emissions of the hot surface depend on surface temperature and on spectral surface emissivity. As this emitted radiation wells upward, it is strongly attenuated through absorption and multiple scattering by the gaseous and particulate components of the dense atmosphere, and it is superimposed by thermal atmospheric emissions. While surface information this way carried to space is completely lost in the scattered sunlight on the dayside, a few narrow atmospheric transparency windows around 1 μm allow the sounding of the surface with nightside measurements.

The successfully completed VEX ('Venus Express') mission, although not dedicated to surface science, enabled a first glimpse at much of the southern hemisphere's surface through the nightside spectral transparency windows covered by VIRTIS-M-IR ('Visible and InfraRed Thermal Imaging Spectrometer, Mapping channel in the IR', 1.0–5.1 μm). Two complementary approaches, a fast semi-empiric technique on the one hand, and a more fundamental but resource-intensive method based on a fully regularized Bayesian multi-spectrum retrieval algorithm in combination with a detailed radiative transfer simulation program on the other hand, were both successfully applied to derive surface emissivity data maps. Both methods suffered from lack of spatial coverage and a small SNR as well as from surface topography maps not sufficiently accurate for the definition of suitable boundary conditions for surface emissivity retrieval.

The recently proposed VERITAS mission ('Venus Emissivity, Radio Science, InSAR, Topography, and Spectroscopy') comprises two instruments, VEM ('Venus Emissivity Mapper') and VISAR ('Venus Interferometric Synthetic Aperture Radar'). This mission will yield a vastly improved data basis with respect to both high SNR Venus nightside radiance measurements at all transparency windows around 1 μm as well as topography maps. The new data will enable the derivation of much more complete and reliable global surface emissivity maps that are required to answer fundamental geologic questions.

Here, we discuss the selection of the wavelength ranges covered by the spectral filters of VEM as well as improved estimates of expectable emissivity retrieval errors based on this selection. For this purpose, the locations of the relevant spectral transparency windows are studied with detailed line-by-line radiative transfer simulations in dependence on different spectral line databases. Recent work on VIRTIS-M-IR/VEX measurements indicated the presence of interferences due to ever-varying atmospheric parameters that cannot be derived from radiance measurements with limited spectral information content to be a dominant source of surface emissivity retrieval errors. This work is carried over to the configuration of VEM, and the retrieval pipeline is optimized to minimize such errors.

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