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Searching for a near-surface particulate layer using near-IR spacecraft observations

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The Venera 13 probe recorded spectrophotometric data of Venus's atmosphere from 62 km down to the surface. While the main dataset was lost, a part of it was reconstructed using the originally published graphic material [1]. The reconstructed downward radiance profiles indicate the presence of a possible near-surface particulate layer (NSPL) in the atmosphere. By fitting these Venera 13 radiance data, NEMESIS [2], a radiative transfer and retrieval tool, is used to retrieve the parameters of the particles forming the NSPL, such as size, abundance, and refractive index. The retrieved layer could have an aeolian or volcanic origin, or it could be formed by volatile transport from the surface. Considering the possible formation mechanisms, it is likely that the NSPL exhibits some form of spatiotemporal variability. On nightside of Venus, it is possible to probe the surface and deep atmosphere (surface up to 15 km altitude) in several near-IR thermal emission windows within the wavelength range of 0.78 to 1.18 μm. Thus, if optical thickness variations of the NSPL exist, then it could be possible to detect them using repeated spacecraft observation in near-IR windows. The instruments EnVision/VenSpec-M and VERITAS/VEM will perform such observations using several surface-observing spectral windows [3, 4]. Motivated by these upcoming missions, simulations are performed to study the effect of the NSPL on near-IR spacecraft observations.

NEMESIS is used to perform simulations of the nightside thermal emission while introducing an assumed variability in the above retrieved NSPL. The sensitivity of the simulated thermal emission spectra to an assumed variability of the NSPL is inspected. However, the main cloud deck (MCD) also shows high variability and affects the surface thermal emission. Thus, the spacecraft observations are simulated by also introducing the variability of MCD in simulations. These simulated spacecraft observations are then corrected for MCD optical thickness variations by following the methodology given by [5] to correct the Venus Express/VIRTIS-M-IR observations. The detectability of the NSPL after correcting the observations for MCD variations is then investigated.

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