Updated radiative transfer model for Titan in the near-infrared wavelength range: Validation on Huygens atmospheric and surface measurements and application to the analysis of the VIMS/Cassini observations of the Dragonfly landing area

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Résumé

Titan is the only moon in the solar system with a thick atmosphere, dominated with nitrogen and organic compounds and a methane- and ethane-based climatic cycles similar to

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the hydrological cycle on Earth. Hence, Titan is a prime target for planetary and astrobiological researches. Heaviest organic materials resulting from atmospheric chemistry (including high atomic number aerosols) precipitate onto the surface and are subject to geological processes (e.g., eolian and fluvial erosion) that lead to the formation of a variety of landscapes, including dune fields, river networks, mountains, canyons, lakes and seas, analogous to their terrestrial counterparts. The analysis of the surface reflectivity in the near-infrared (NIR) allows to constrain the surface composition, which in turn is crucial to understand the processes leading to the formation and evolution of planetary landscapes. However, Titan's atmosphere prevents the surface from being probed in the NIR. Incident and reflected solar radiations are strongly affected by gaseous absorption and aerosol scattering at almost all the wavelengths in the NIR. Only where the methane absorption weak enough, narrow transmission windows allow the detection of radiation coming from the low atmosphere and from the surface. In the 0.88-5.11 μm range, the Visual and Infrared Mapping Spectrometer (VIMS) instrument on board the Cassini spacecraft has shown that the surface can be observed in eight transmission windows centered at 0.93, 1.08, 1.27, 1.59, 2.03, 2.69, and 2.78 μm, and in the 5.0-5.11 μm interval. We present an analysis of Titan data acquired by VIMS, making use of an updated radiative transfer model with up-to-date gaseous abundances profiles and absorption coefficients and improved photochemical aerosol optical properties. Our RT model is validated using the in situ observations of DISR acquired during descent and once landed. We apply our model to four hyper-spectral VIMS cubes over the Selk crater which is the Dragonfly Landing Area, drastically diminishing seams between cubes due to atmosphere and varying observation geometry. Coupled with an efficient inversion scheme, our model can be apply to the Cassini's VIMS complete dataset for the retrieval of Titan's atmospheric opacity and surface albedos at regional and global scales.