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Investigation of Titan's surface and atmosphere photometric functions using the Cassini/VIMS instrument

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After 106 flybys spread over 10 years, the Cassini Visual and Infrared Mapping Spectrometer (VIMS) instrument acquired 33151 hyperspectral cubes pointing at the surface of Titan on the dayside. Despite this huge amount of data available for surface studies, and due to the strong influence of the atmosphere (methane absorption and haze scattering), Titan's surface is only visible with VIMS in 7 spectral atmospheric windows centred at 0.93, 1.08, 1.27, 1.59, 2.01, 2.7-2.8 and 5 microns. Atmospheric scattering and absorption effects dominate Titan's spectrum at wavelengths shorter than 3 microns, while the 5 micron window, almost insensitive to the haze scattering, only presents a reduced atmospheric absorption contribution to the signal recorded by VIMS. In all cases, the recorded I/F represents an apparent albedo, which depends on the atmospheric contributions and the surface photometry at each wavelength. We therefore aim to determine real albedo values for Titan's surface by finding photometric functions for the surface and the atmosphere that could be used as a basis for empirical corrections or Radiative Transfer calculations.

After updating the navigation of the VIMS archive, we decomposed the entire VIMS data set into a MySQL relational database gathering the viewing geometry, location, time (season) and I/F (for pure atmosphere and surface-atmosphere images) for each pixel of the 33151 individual VIMS cubes. We then isolated all the VIMS pixels where Titan's surface has been repeatedly imaged at low phase angles (< 20 degrees) in order to characterize phase curves for the surface at 5 microns and for the atmosphere. Among these, the T88 flyby appears noteworthy, with a "Emergence-Phase Function (EPF)"-type observation: 25 cubes acquired during the same flyby, over the same area (close to Tortola Facula, in relatively dark terrains), at a constant incidence and with varying emergence and phase (from 0 to 60 degrees) angles. The data clearly exhibit an increase of I/F at 5 microns at very low phase angles, which is indicative of an opposition effect for the surface, and kinks in the I/F at low and high emergence/phase angles, increasing with decreasing wavelength (and thus with increasing atmospheric scattering). The latter dependency is present in both pure atmosphere and surface-atmosphere images, which clearly indicates that it is of atmospheric origin. We are currently investigating these dependencies with angles and try to determine best fit models that would describe the phase curves for the surface at 5 microns and for the atmosphere at lower wavelengths in this particular area.