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Titan's Surface Composition from Cassini VIMS Solar Occultation Observations

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Titan's surface is obscured by a thick absorbing and scattering atmosphere, allowing direct observation of the surface within only a few spectral win-dows in the near-infrared, complicating efforts to identify and map geologically important materials using remote sensing IR spectroscopy. We there-fore investigate the atmosphere's infrared transmission with direct measure-ments using Titan's occultation of the Sun as well as Titan's reflectance measured at differing illumination and observation angles observed by Cas-sini's Visual and Infrared Mapping Spectrometer (VIMS). We use two im-portant spectral windows: the 2.7-2.8-mm "double window" and the broad 5-mm window. By estimating atmospheric attenuation within these windows, we seek an empirical correction factor that can be applied to VIMS meas-urements to estimate the true surface reflectance and map inferred composi-tional variations. Applying the empirical corrections, we correct the VIMS data for the viewing geometry-dependent atmospheric effects to derive the 5-μm reflectance and 2.8/2.7-μm reflectance ratio. We then compare the cor-rected reflectances to compounds proposed to exist on Titan's surface. We propose a simple correction to VIMS Titan data to account for atmospheric attenuation and diffuse scattering in the 5-mm and 2.7-2.8 mm windows, generally applicable for airmass < 3.0. We propose a simple correction to VIMS Titan data to account for atmospheric attenuation and diffuse scatter-ing in the 5-mm and 2.7-2.8 mm windows, generally applicable for airmass < 3.0. The narrow 2.75-mm absorption feature, dividing the window into two sub-windows, present in all on-planet measurements is not present in the occultation data, and its strength is reduced at the cloud tops, suggesting the responsible molecule is concentrated in the lower troposphere or on the sur-face. Our empirical correction to Titan's surface reflectance yields properties shifted closer to water ice for the majority of the low-to-mid latitude area covered by VIMS measurements. Four compositional units are defined and mapped on Titan's surface based on the positions of data clusters in 5-mm vs. 2.8/2.7-mm scatter plots; a simple ternary mixture of H_2O, hydrocarbons and CO_2 might explain the reflectance properties of these surface units. The vast equatorial "dune seas" are compositionally very homogeneous, perhaps suggesting transport and mixing of particles over very large distances and/or and very consistent formation process and source material. The composi-tional branch characterizing Tui Regio and Hotei Regio is consistent with a mixture of typical Titan hydrocarbons and CO_2, or possibly methane/ethane; the concentration mechanism proposed is something similar to a terrestrial playa lake evaporate deposit, based on the fact that river channels are known to feed into at least Hotei Regio.