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Analysis of solar occultation observations in the near infrared: implications for Titan's atmospheric properties and its surface composition

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One of Titan's many unique characteristics is the presence of dense atmosphere where organic particles are produced and form a haze layer. The Visual and Infrared Mapping Spectrometer (VIMS) onboard the Cassini spacecraft has demonstrated that Titan's surface can be observed in several atmospheric windows between 0.8- and 5-μm where the interaction between the light and the organic particles can be studied. Eight flybys have so far provided solar occultation observations probing Titan's atmosphere at different latitudes. The light curves obtained in seven atmospheric windows between 0.933-μm to 5-μm allow us to characterize atmospheric layers from 300 km to the surface. Light curves with very good fits are obtained using a simple profile of number density of aerosols that is characterized by a scale height. Since different wavelengths sample different altitudes, we propose a density profile that is compared to that obtained by the Huygens probe during its descent in the equatorial region. The value of the scale height increases with altitude at the South Pole whereas it decreases at the equator, which can be explained by the global circulation and the presence of upwelling at the South Pole. This study shows that the opacity is larger at the equator than at the South Pole during Titan's winter. Retrieving the opacity of this organic haze allows us to determine the surface reflectance, which is key information to infer the composition of Titan's surface. At 2-μm, the 2-way vertical transmission varies from 22% at the equator to 40% at the South Pole, making surface terrains of same albedo look brighter at the pole than at the equator. As expected, the transparency of the atmosphere increases with wavelength. The two-way vertical transmission is around 80% at 5 μm. It shows that Titan can be imaged very efficiently at 5 micron.

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