Constraining Titan's North Polar Haze Structure From Specular Reflections.

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Introduction: While Huygens measured the haze profile in Titan's tropics during its 2005 descent [1], the vertical distribution of aerosols at the poles appears significantly different [2]. Our lack of quantitative understanding of haze over the north polar lake district in particular inhibits the ability of radiative transfer models to understand surface albedos and spectra in that region of critical science interest. Because stellar occultation measurements do not probe Titan's lower atmosphere, a novel approach is needed.

Barnes et al. (2013)[3] calculated optical depth within Titan's northern polar atmosphere as a function of reconstructed I/F values and α(i) (the amount of normal atmospheres traversed by a photon with incidence angle i) using data gained from specular reflections. Barnes et al. (2013)[3]used the measured specular intensity to derive a transmission spectrum across the channels in Titan's atmosphere corresponding to the known atmospheric windows.

However, the scope of the initial results were limited in that the observations were based upon a singular Cassini/VIMS spectral image cube: CM_1721848119_1, that was collected during the T85 flyby. From that time until the completion of the Cassini mission, the VIMS instrument has captured numerous spectral image cubes containing specular reflections. Starting with an initial survey of cubes from a select number of flybys after T100, we expand upon this work by comparing optical depth at various incidence angles. Spectral image cubes from the entire range of flybys catalogued in the Titan specular point database by Seignovert et al. (2020)[4] will allow transmission measurements in the 1.6 μm and 1.3 μm windows, which would allow a comparison to be made with data from the Huygens landing site. Ultimately, the deviation from 1/cos(i) in measured optical depths as a function of incidence angle contains signatures of how the optical depth varies with altitude, which can inform how Titan's polar haze differs from that measured by Huygens at the equator.

References: [1] Tomasko. M.G., Doose. L., Engel. S., et al. (2008) *Planet. And Space Sci.*, V56, I5, 669-707. [2] Le Mouélic. S., Cornet. T., Rodriguez. S., et al. (2012) *Planet. And Space Sci.*, V73, I1, 178-190. [3] Barnes. J.W., Clark, R.N., Sotin. C., et al. (2013) *ApJ, 777,* 161. [4] Seignovert. B., Sotin. C., Lawrence. K.J., Heslar. M.F. (2020) *LPSC LI.*