



## Aerosol properties and evolution at different timescales in Titan's atmosphere from Cassini UVIS observations throughout the mission

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Aerosols, the main product of Titan's atmosphere, significantly influence the moon's global climate, and photochemical processes [2, 7, 6, 3]. Characterizing this haze is crucial to constrain and validate theoretical microphysics models [8], and understand the complex prebiotic processes occurring in what is considered as a primitive Earth-like environment [10, 4].

The Cassini spacecraft's instruments can help characterize aerosols by the extinction they provoke, through stellar occultation measurements performed by VIMS [1] or UVIS [5], retrievals from thermal emission observed by CIRS [14], or by direct imaging with ISS [12]. Extinction, however, depends on both the density and size of aerosol particles, and determining these two quantities remains a challenge as well as a necessity. Huygens measurements analyzed by Tomasko et al. [13] constrained these physical properties, but only for a narrow range of altitude on a specific Titan location. Some studies [1, 14] derived density profiles assuming these size properties. Scattered light observations with ISS allowed to constrain the haze radius and density at the detached haze layer near 500 km [11, 15]. However, at higher altitudes where the haze formation takes place, there are no constraints for the haze microphysical properties.

We present a new analysis of Cassini's Ultraviolet Imaging Spectrograph (UVIS) data allowing to retrieve both haze particle size and density as altitude profiles at different latitudes across time during the mission. UV light is suitable to derive haze properties at high altitudes where the early stages of photochemistry and haze formation and growth take place [8, 9]. We use FUV channel airglow spectra, where the strong effect of haze scattering can be seen as a continuous radiance feature between 1600 and 1900 Å. We integrate this wavelength range to obtain a single radiance value and we use limb observations to derive the radiance profile as a function of altitude.

To reproduce these profiles, we forward model the radiative transfer processes (from gases and aerosols) and the N<sub>2</sub> airglow based on each observation geometry. We model the atmosphere as spherical layers, considering a log-normal distribution of haze particle radius, with mean radius and particle density set as free parameters in each layer. With sufficient observations at different phase angles, we fit the aerosol phase function curve, which directly depends on the aerosol bulk radius. Thus we retrieve the particle radius and the particle density. We fit for this reason the radiance profiles of all observations in a given year at once, assuming the atmospheric structure remains stable throughout the year.

Observations for each fly-by are binned by altitude and latitude to increase signal-to-noise ratio while keeping a sufficient spatial resolution. Our radiance profiles cover altitudes from 1500 km to the surface. We retrieve haze properties between 200 km and about 800 km. The whole Cassini mission coverage is used to derive haze properties across different latitude locations, and across the

years to derive time-dependant characteristics (on annual timescale) and seasonal changes. Simultaneous analysis of both limbs allow to differentiate morning and evening parts of Titan and derive differences on a Titanian day scale.

Several fly-bys performed limb observation with a very high phase angle ( $>150^\circ$ ), giving us unique opportunities to observe both sunrise and sunset limbs in similar illumination conditions. We report an unforeseen feature in the radiance profiles observed during such flybys. Peak radiance is produced at notably different altitudes and haze properties are not sufficient to explain such daily difference. We present the analysis conducted to confirm this feature and explore potential phenomena explaining its specific characteristics.

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