A new description of Titan's aerosol optical properties from the analysis of VIMS Emission Phase Function observations. Sébastien Rodriguez[1], Maël Es-sayeh[1], Pascal Rannou[2], Maélie Coutelier[3], Luca Maltagliati[4], Thomas Cornet[5], Stéphane Le Mouélic[6] and Christophe Sotin[6]. [1]Université Paris Cité, Institut de physique du globe de Paris (IPGP), CNRS, Paris, France. [2]Groupe de Spectrométrie Moléculaire et Atmosphérique, UMR CNRS 7331, Université de Reims Champagne-Ardenne, Reims, France. [3]LATMOS/IPSL, UVSQ Université Paris-Saclay, Sorbonne Université, CNRS, Guyancourt, France. [4]Nature Astronomy, Springer Nature, 4 Crinan Street, London, N1 9XW, UK. [5]Aurora Technology BV for ESA, European Space Agency, European Space Astronomy Centre (ESAC), Camino Bajo del Castillo s/n, Villanueva de la Canada, 28692, Madrid, Spain. [6]Laboratoire de Planétologie et Géosciences, CNRS UMR 6112, Nantes Université, Université d'Angers, Université du Mans, Nantes, France.

Introduction: The Huygens probe gave unprecedented information on the properties of Titan's aerosols (vertical distribution, opacity as a function of wavelength, phase function, single scattering albedo) by in-situ measurements [1]. Being the only existing in-situ atmospheric probing for Titan, this aerosol model currently is the reference for many Titan studies (e.g. by being applied as physical input in radiative transfer models of the atmosphere). A reanalysis of the DISR dataset, corroborated by data from the Downward- Looking Visible Spectrometer (DLVS), was carried out by the same group [2], leading to significant changes to the indications given by [1]. Recent work from [3] also refine the optical properties of Titan's haze particle, leading in particular to a change in their required fractal dimension.

Here we present the analysis of the Emission Phase Function observation (EPF) performed by VIMS during the Cassini Titan flyby T88 (November 2012) in terms of aerosol optical properties.

Observations: An EPF observes the same spot on the surface (and thus the same atmosphere) with the same incidence angle but with different emergence and phase angles. In this way, our VIMS EPF allows, for the first time, to have direct information on the phase function of Titan's aerosols, as well as on other important physical parameters as the behavior of their extinction as a function of wavelength and the single scattering albedo (also as a function of wavelength) for the whole VIMS range (0.8-5.2 μm). The T88 EPF is composed of 26 VIMS datacubes spanning a phase angle range approximately from 0°to 70°.

Model: We used the radiative transfer model described in [4] as baseline, updated with improved methane (+ related isotopes) spectroscopy and aerosol description [5]. By changing the aerosol description in the model, we found the combination of aerosol optical parameters that fits best a constant aerosol column density over the whole set of the VIMS datacubes of the EPF sequence of observations.

Result: We confirmed that the results from [2] and [3] do improve the fit for what concerns the vertical profile and the extinction as a function of wavelength. However, a different phase function with respect to what they propose must be employed, especially towards the backscattering region. This has important implications in terms of aerosol physical (size and structure) and chemical (composition and mixing with liquids) properties.

References: [1] Tomasko et al. (2008) *Planetary and Space Science, 56, 669*. [2] Doose et al. (2016) *Icarus, 270, 355*. [3] Coutelier et al. (2021) *Icarus, 364, 114464*. [4] Hirtzig et al. (2013) *Icarus, 226, 470*. [5] Es-sayeh et al. (2023), *PSJ, in reviews*.

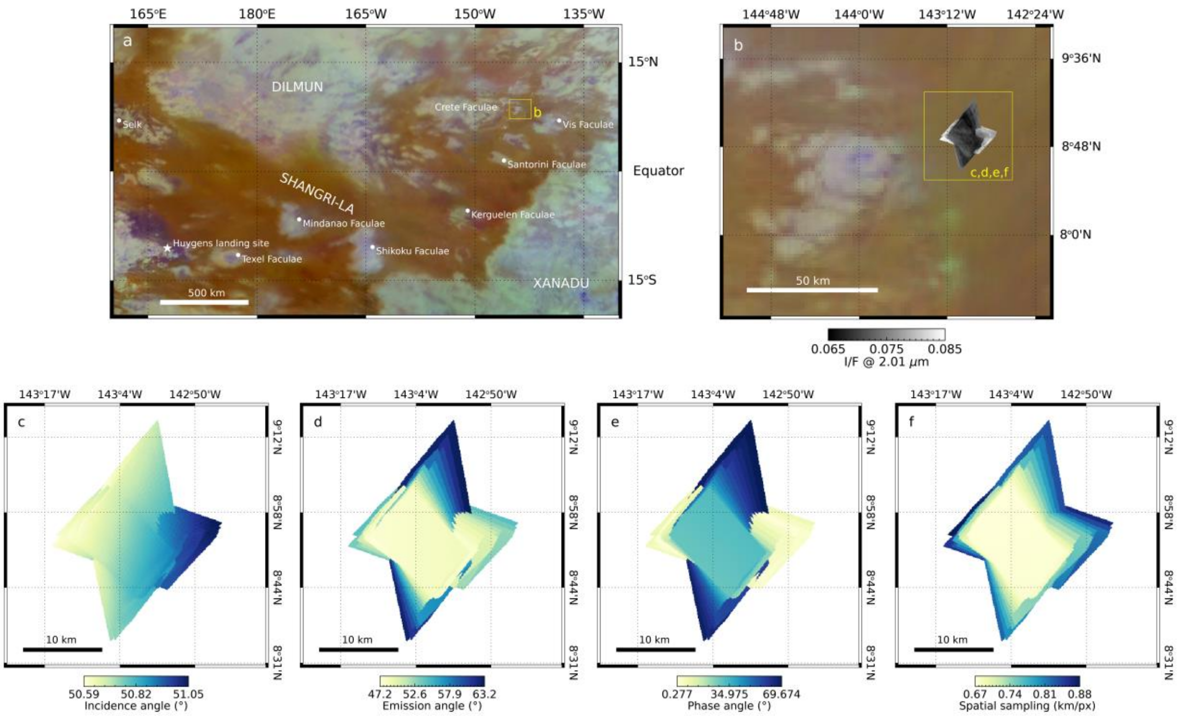

Figure 1: Location and geometries (incidence, emergence, and phase angles, and spatial sampling) of the T88 EPF VIMS sequence of observations.