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Seasonal Variability of Stratospheric H_2O on Titan

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Titan is Saturn's largest moon and one of the most complex Earth-like bodies in our Solar system. It hosts a thick, complex atmosphere with weather systems [1], rich C-N-H photochemistry [2], and unique surface features such as lakes of methane [3]. The presence of organic hazes and oxygen-bearing molecules in the atmosphere make Titan astrobiologically important and provides an analogous natural laboratory to study pre-biotic Earth [4] and exoplanets with similar climates. Understanding Titan's atmosphere is also pertinent to inform NASA's Dragonfly mission set to arrive in 2034 [5].

Water vapour is an important, yet poorly understood presence in Titan's atmosphere. It plays a vital role in distributing oxygen molecules, which are otherwise scarce, throughout the planet to form species such as CO, CO_2 and H_2CO [2]. Water vapour was first detected in Titan's atmosphere in 1998 by the Infrared space Observatory [6]. Since then, only a handful of studies from Herschel [7], CIRS [8] and the INMS [9] instruments have provided observations. Due to modelling difficulty and its low abundances, there is limited information on seasonal, global and vertical abundances of Titan's H_2O with research focusing on averages and single measurements.

146 far-IR observations acquired by CIRS on-board the Cassini spacecraft were analysed to form the first-reported global picture of H_2O abundances in Titan's stratosphere across its 13-year mission, improving on previous studies. Using the most recent photochemical model [2] as an a priori in the NEMESIS radiative transfer modelling tool [10] and a new method of applying parameterised gaussian cross-sections [11] to fit the poorly understood hazes, we present results showing the seasonal variability of water vapour at pressures of ~ 0.1-10 mbar. We discuss our results and its implications, and compare our findings to previous work.

References: [1] N.A. Teanby et al. (2017) **Nat. Commun.** *8*, 1586. [2] V. Vuitton et al. (2019) **Icarus** *324*, 120-190. [3] M. Mastrogiuseppe et al. (2019) **Nat. Astron.** *3*, 535-542. [4] D.W. Clarke and J.P. Ferris (1997) **Orig. Life Evol. Biosph.** *27*, 225-248. [5] J.W. Barnes et al. (2021) **Planet. Sci. J.** *2*, 130. [6] A. Coustenis et al. (1998) **A&A** *336*, 85-89. [7] R. Moreno et al. (2021) **Icarus** *221*, 753-767. [8] V. Cottini et al. (2012) **Icarus** *220*(2), 855-862. [9] J. Cui et al. (2009) **Icarus** *200*, 581-615. [10] P.G.J. Irwin (2008) **J. Quant. Spec. Radiat. Transf.** *109*, 1136–1150. [11] N.A. Teanby (2007) **Math**

Geol, 39, 419–434. [12] S. Bauduin et al. (2018**) Icarus**, 311, 288-305.