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Retrieval of H_2O abundance in Titan's stratosphere: a (re)analysis of CIRS/Cassini and PACS/Herschel observations

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The presence of water vapour (H_2O) in Titan's stratosphere has been attested 20 years ago by the Infrared Space Observatory and is the result of external sources. Since this discovery, the H_2O mole fraction in Titan's stratosphere is still uncertain, due especially to large discrepancies between the few available measurements. More particularly, the recent measurements made from the Herschel observatory (PACS and HIFI) and from the CIRS/Cassini instrument differ by a factor of around 4. This difference has prevented current photochemical models from fully constraining the oxygen flux flowing into Titan's atmosphere and, as a result, to determine the main source of oxygen in Titan's atmosphere.

In this work, we try to understand the differences between the H_2O mole fractions estimated from PACS/Herschel and CIRS/Cassini observations. The strategy for this is 1) to analyse recent disc-averaged observations of CIRS to investigate if the observation geometry could explain the previous discrepancies, and 2) to (re)analyse the three types of observation with the same retrieval scheme to assess if previous differences in the retrieval code/methodology could be responsible for the discrepancies observed between the instruments. After presenting the methodology applied to all observations, we will show that using the same retrieval scheme does not reconcile the H_2O mole fractions estimated from all measurements. Large differences between one disc-averaged set of CIRS observations and PACS measurements are indeed revealed, and raise new questions regarding the possibility of latitudinal variations of H_2O in Titan's stratosphere. As already shown for nitriles and hydrocarbons, the meridional circulation could indeed potentially affect the latitudinal distribution of H_2O through the upwelling or subsidence of H_2O-rich air. This hypothesis will be discussed along with the possible influence of time variation of the OH/H_2O input flux in Titan's atmosphere. In future work, the analysis of more observations will be needed to address the questions arising from this work and to improve the understanding of the sources and chemistry of H_2O in Titan's atmosphere.