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Evolution of Titan's stratosphere with Cassini/CIRS

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Titan is a unique body in the solar system in particular because of its earth-like surface features, its putative undersurface liquid water ocean and its large organic content in the atmosphere and on the surface . These chemical species evolve with season, as Titan follows Saturn in its orbit around the Sun with an inclination of about 27°. We performed an analysis of spectra acquired by Cassini/CIRS at high resolution covering the range from 10 to 1500 cm^{-1} since the beginning and until the last flyby of Titan in 2017 and describe the temperature and composition variations ([1-3]. By applying our radiative transfer code (ARTT) to the high-resolution CIRS spectra we study the stratospheric evolution over almost two Titan seasons [1,2]. CIRS nadir and limb spectral together show variations in temperature and chemical composition in the stratosphere during the Cassini mission, before and after the Northern Spring Equinox (NSE) and also during one Titan year.

Since the 2010 equinox we have thus reported on monitoring of Titan's stratosphere near the poles and in particular on the observed strong temperature decrease and compositional enhancement above Titan's southern polar latitudes since 2012 and until 2014 of several trace species, such as complex hydrocarbons and nitriles, which were previously observed only at high northern latitudes. This effect followed the transition of Titan's seasons from northern winter in 2002 to northern summer in 2017, while at that latter time the southern hemisphere was entering winter.

Our data show a continued decrease of the abundances which we first reported to have started in 2015. The 2017 data we have acquired and analyzed here are important because they are the only ones recorded since 2014 close to the south pole in the far-infrared nadir mode at high resolution. A large temperature increase in the southern polar stratosphere (by 10-50 K in the 0.5 mbar-0.05 mbar pressure range) is found and a change in the temperature profile's shape. The 2017 observations also show a related significant decrease in most of the abundances which must have started sometime between 2014 and 2017 [3]. In our work, we show that the equatorial latitudes remain rather constant throughout the Cassini mission.

We have thus shown that the south pole of Titan is now losing its strong enhancement, while the north pole also slowly continues its decrease in gaseous opacities. It would have been interesting to see when this might happen, but the Cassini mission ended in September 2017. Perhaps future ground-based measurements and the Dragonfly mission can pursue this investigation and monitor Titan's atmosphere to characterize the seasonal events. Our results set constraints on GCM and photochemical models.

References:

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