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Evolution of minor trace gases and isotopic ratios in Titan's stratosphere using CIRS/Cassini spectra

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The Cassini/Huygens mission has extensively studied Titan's environment and for the first time provided temporal and spatial variability information since 2004. Here, we focus on the stratosphere with its complex organic chemistry by using the wealth of the infrared spectra retrieved by the Composite Infrared Spectrometer (CIRS) consisting of two interferometers, aboard Cassini (1). These data cover a large part of Titan's globe in high, medium and low resolution (0.5cm-1, 2.5cm-1 and 15.5cm-1 respectively). CIRS has mapped the stratosphere in more than 70 flybys so far either in downward or horizontal viewing in the range 10-1400cm-1.
First, we import large FP4 averages (1100-1400cm-1), using the nu4 methane band as a thermometer, into an inverse algorithm (2, 3) to retrieve the corresponding vertical temperature profile and apply it to our line-by-line radiative tranfer code (RTC) (4, 5). Then, through an iterative best-fit process, we construct a model spectrum fitting the relative FP3 average (600-1100cm-1). Eventually, we infer the abundances of each spectroscopic query trace gases and we can study temporal and spatial evolutions (6). We have upgraded our recipe by adopting recent laboratory spectroscopic results (7, 8) and the aerosol influence (9).
The upgraded RTC with the breadth of CIRS recordings help us study the infrared signature of Titan's stratospheric weak trace gases (C6H6, C2HD, HC3N). Moreover, we look for new isotopologues (12C13CH6, H13CCCN, H12CC13CN, H12CC13CN, DC14N, H13CN, $13C16O_2$, C18O16O, C17O16O, 13C17O16O, $13C18O_2$, 13C18O16O, C18O16O) and calculate 13C/12C, D/H, 15N/14N, 17O/16O and 18O/16O isotopic ratios throughout Titan's atmosphere. We compare our results to other publications (10-14) and give upper limits for the weakest species. Since the stratospheric composition varies over a Saturnian year (6), the trace gases abundances and their isotopologues help us understand Titan's atmospheric dynamics and photochemical evolution giving clues about their sources and sinks.

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