C_3H_X HYDROCARBON ABUNDANCE IN TITAN'S ATMOSPHERE FROM CASSINI INFRARED SPECTRA.

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Introduction: The atmosphere of Titan bears a striking resemblance to that hypothesized for the early Earth. With a 95% N_2 and 5% CH_4 tropospheric composition, the atmosphere is highly reducing and is host to a diverse suite of trace gases. High in the atmosphere, CH_4 is photodissociated into several smaller, highly reactive species that may react with each other to form larger molecules. These larger molecules are also subject to photochemical attack and other reactions which lead to a complicated process of production and destruction that yield the plethora of hydrocarbons present in Titan's atmosphere.

After the Voyager flyby of 1980, spectra from the InfraRed Interferometer Spectrometer (IRIS) instrument were used to make the first detections of C_3H_8 (propane) and C_3H_4 (methylacetylene). Over 30 years later, C_3H_6 (propylene) was detected using spectra from the Composite InfraRed Spectrometer (CIRS) instrument on Cassini [1]. The gas was not able to be properly modeled, however, due to the lack of a spectral linelist. An estimate of abundance was calculated by comparing the relative intensities of propane and propylene lines.

Recently, a pseudo-linelist for propylene was constructed, enabling us to perform the first measurement of propylene in Titan's atmosphere. We also measure the abundance of propane and methylacetylene, and discuss a new upper limit of allene, the currently undetected isomer of methylacetylene.

Methods: The longetivity of the Cassini mission has allowed for a unique approach to the search for trace gases in Titan's atmosphere. We use a binning scheme of two time spans, 2004-2009 and 2012-2015, and three latitude ranges, 60˚S-20˚S, 20˚S-20˚N, and 20˚N-60˚N, to combine similar observations of Titan's limb. Using this method, we are able to increase the S/N of datasets used for modeling, making it possible to accurately model the weak 921.5 cm emission feature of propylene. We are also able to determine spatial and seasonal variations of modeled gases, including methylacetylene, propane, and propylene.

A similar approach was taken in attempt to identify allene on Titan using an updated linelist. We use a single 25˚S-25˚N bin spanning the 2004-2015 time span.

Discussion: The abundance profiles of propane and methylacetylene that we retrieve are comparable to previously published profiles.

Titan experiences a global convective, which transports gases produced high in the equatorial atmosphere towards the winter pole, where the gases are downwelled towards the lower stratosphere. In our first measurement of propylene, however, the gas shows a maximum abundance in the stratosphere above the equator. Our profiles also disagree with predictions made from photochemical models, showing a higher abundance above the ~1mbar altitude than models predict, as shown in Fig. 1.

While we were unable to make a detection of allene, we present an updated upper limit for the 30˚S-30˚N region.

References:

[1] Nixon, C. A. et al (2013) *ApJL, 776,* L14. [2] Li, C. et al (2015) *ApJL, 803*, L19. [3] Hebrard, E. et al (2013) *A&A, 552*, A132. [4] Dobrijevic, M. et al (2016) *Icar, 268*, 313-339.

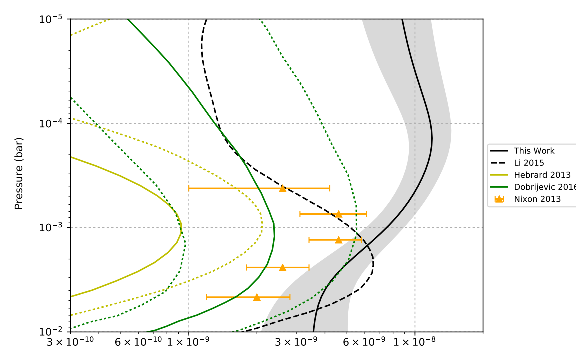

Figure 1: Comparison between our retrieved profile for the 2004-2009, 20˚S-20˚N bin to several propylene predictions [2] [3] [4].