INVESTIGATING THE DIFFERENT STEPS OF TITAN'S ATMOSPHERIC CHEMISTRY AT LOW TEMPERATURE: GAS PHASE ANALYSIS. E. Sciamma-O'Brien, and F. Salama, NASA Ames Research Center, Moffett Field, California, USA (ella.m.sciammaobrien@nasa.gov).

Introduction: Titan's atmosphere, composed mainly of N_2 and CH_4, is the siege of a complex chemistry induced by solar UV radiation and electron bombardment from Saturn's magnetosphere. This organic chemistry occurs at temperatures lower than 200 K and leads to the production of heavy molecules and subsequently solid aerosols that form the orange haze surrounding Titan. Since 2004, the instruments onboard the Cassini orbiter have generated large amounts of observational data, unraveling an atmospheric chemistry on Titan much more complex than what was first expected, particularly in the upper atmosphere. Neutral, positively and negatively charged heavy molecules have been detected in the ionosphere of Titan[1,2], including benzene (C_6H_6) and toluene ($C_6H_5CH_3$)[3]. The presence of these critical precursors of polycyclic aromatic hydrocarbon (PAH) compounds suggests that PAHs might play a role in the production of Titan's aerosols.

The Titan Haze Simulation (THS) Experiment: The THS experiment has been developed on the COSmIC simulation chamber at NASA Ames to study the different steps of Titan's atmospheric chemistry at low temperature. The chemistry is simulated by plasma in the stream of a supersonic expansion. With this unique design, the gas mixture is adiabatically cooled to Titan-like temperature (~150 K) *before* inducing the chemistry by plasma discharge. Different gas mixtures containing N_2, CH_4, and the first products of the N_2-CH_4 chemistry (C_2H_2, C_2H_4, C_6H_6…) but also heavier molecules such as PAHs or nitrogen containing PAHs (PANHs) can be injected to study specific chemical pathways. Both the gas phase and solid phase products resulting from the plasma-induced chemistry can be monitored and analyzed. Cavity ring down spectroscopy[4] and mass spectrometry[5] are used for the gas phase analysis; Scanning Electron Microscopy (SEM), Gas Chromatography-Mass Spectrometry (GC-MS), mass spectrometry and IR spectroscopy are used for the solid phase analysis.

Gas phase analysis: Here we present and discuss the results of a recent mass spectrometry study of the gas phase products[6]. N_2-CH_4, N_2-CH_4-C_2H_2 and N_2-CH_4-C_6H_6 mixtures were used to highlight the chemical growth evolution when injecting heavier hydrocarbon trace elements in the initial N_2-CH_4 mixture: structures up to 6-C were observed with acetylene and up to 12-C with benzene as shown in Fig. 1. These results show the uniqueness of the THS experiment, due to the short residence time of the gas in the plasma discharge, to help understand the first and intermediate steps of Titan's atmospheric chemistry as well as specific chemical pathways leading to Titan's haze formation.

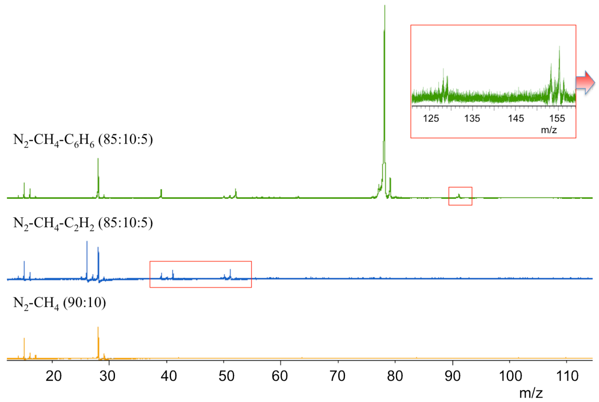

Figure 1: Mass spectra of the positive ions produced in N_2-CH_4, N_2-CH_4-C_2H_2 and N_2-CH_4-C_6H_6 gas mixtures showing the chemical growth evolution in the THS experiment when injecting heavier hydrocarbon in the initial gas mixture.

References:

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