THE THS EXPERIMENT: SIMULATING TITAN'S ATMOSPHERIC CHEMISTRY AT LOW TEMPERATURE. E. Sciamma-O'Brien[1,2], K. T. Upton[3], J. L. Beauchamp[3], and F. Salama[1], [1]NASA ARC, mail Stop 245-6, Moffett Field, CA (ella.m.sciammaobrien@nasa.gov), [2]Bay Area Environmental Research Institute, Petaluma, CA, [3]Noyes Laboratory of Chemical Physics and the Beckman Institute - Caltech, Pasadena, CA.

Introduction: Titan, Saturn's largest moon, is the only solid body in the outer solar system with a dense atmosphere. In Titan's atmosphere, composed mainly of nitrogen (N_2 at 95-98%) and methane (CH_4 at 2-5%), a complex chemistry occurs at temperatures lower than 200 K, and leads to the production of heavy organic molecules and subsequently solid aerosols that form the orange haze surrounding Titan. Because the reactive carbon and nitrogen species present in Titan's aerosols could meet the functionality requirements for precursors to prebiotics, the study of Titan's aerosol has become a topic of extensive research in the fields of astrobiology and astrochemistry.

The Titan Haze Simulation (THS): In the study presented here, we used the Titan Haze Simulation (THS) experiment, an experimental setup developed at the NASA Ames Cosmic simulation (COSmIC) facility to study Titan's atmospheric chemistry at low temperature, and produce aerosols representative of the early stages of Titan's aerosol formation. In the COSmIC/THS, the chemistry is simulated by plasma in the stream of a supersonic expansion. With this unique design, the gas is jet-cooled to Titan-like temperature (~150K) *before* inducing the chemistry by plasma[1], and remains at low temperature in the plasma discharge (~200K). Because of the pulsed nature of the plasma, the residence time of the gas in the discharge is only a few microseconds, which leads to a truncated chemistry and allows for the study of the first and intermediate steps of the chemistry. Different N_2-CH_4-based gas mixtures can be injected in the plasma, with or without the addition of heavier precursors present as trace elements on Titan, in order to monitor the evolution of the chemical growth. Both the gas phase and solid phase products resulting from the plasma-induced chemistry can be monitored and analyzed using a combination of complementary *in situ* and *ex situ* diagnostics.

In a recently published study[2], a mass spectrometry analysis of the gas phase has demonstrated that the COSmIC/THS is a unique tool to probe the first and intermediate steps of Titan's atmospheric chemistry at Titan-like temperature (cf. Fig. 1). In particular, the mass spectra obtained in a N_2-CH_4-C_2H_2-C_6H_6 mixture are relevant for comparison to Cassini's CAPS-IBS instrument. The results of a complementary study of the solid phase are consistent with the chemical growth evolution observed in the gas phase. Scanning Electron Microscopy images have shown that aggregates produced in N_2-CH_4-C_2H_2-C_6H_6 mixtures are much larger (up to 5 **µ**m in diameter) than those produced in N_2-CH_4 mixtures (0.1-0.5 **µ**m). Direct Analysis in Real Time mass spectrometry (DART-MS) combined with Collision Induced Dissociation (CID) have detected the presence of aminoacetonitrile, a precursor of glycine, in the THS aerosols. X-ray Absorption Near Edge Structure (XANES) measurements also show the presence of imine and nitrile functional groups, showing evidence of nitrogen chemistry. These complementary studies show the strong capability of COSmIC/THS to better understand Titan's chemistry, and illustrate the high potential of Titan's environment for the formation of prebiotic molecules.

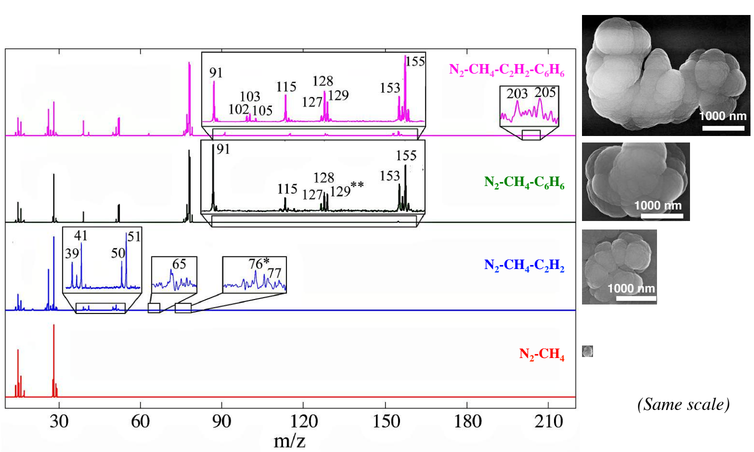

Figure 1. TOF mass spectra of four gas mixtures showing the chemical growth evolution when adding heavier hydrocarbons in the initial gas mixture. The SEM images on the right show that larger aggregates are produced from heavier precursors, in agreement with the gas phase results.

References:

[1] Biennier L., Benidar A. and Salama F. (2006) *Chem. Phys., 326,* 445-457.
[2] Scaimma-O'Brien E., Ricketts C. L. and Salama F. (2014) *Icarus, 243,* 325-336.

Acknowledgments: This research is supported by the NASA SMD PATM Program. K.T. Upton acknowledges the support of the NASA JPFP Program. The SEM images were obtained at the UCSC MACS Facility at Ames. The authors acknowledge the outstanding technical support of R. Walker and E. Quigley.