The THS experiment: simulating Titan's atmospheric chemistry at low temperature (200K)

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In Titan's atmosphere, composed mainly of N_2 (95-98%) and CH_4 (2-5%), a complex chemistry occurs at low temperature, and leads to the production of heavy organic molecules and subsequently solid aerosols. Here, we used the Titan Haze Simulation (THS) experiment, an experimental setup developed at the NASA Ames COSmIC simulation facility to study Titan's atmospheric chemistry at low temperature. In the THS, the chemistry is simulated by plasma in the stream of a supersonic expansion. With this unique design, the gas is cooled to Titan-like temperature (~150K) *before* inducing the chemistry by plasma, and remains at low temperature in the plasma discharge (~200K). 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- 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.

A recent mass spectrometry[1] study of the gas phase has demonstrated that the THS is a unique tool to probe the first and intermediate steps of Titan's atmospheric chemistry at Titan-like temperature. 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. Grains and aggregates form in the gas phase and can be jet deposited on various substrates for ex situ analysis. Scanning Electron Microscopy images show that more complex mixtures produce larger aggregates. A mass spectrometry analysis of the solid phase has 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 high potential of THS to better understand Titan's chemistry and the origin of aerosol formation.

Reference: [1] Sciamma-O'Brien, Ricketts and Salama, 2014, *Icarus* 243, 325.