



The Chemical Composition of Simulated Titan's Mid-Atmospheric Aerosols

Diana Laufer, Ronen Jacovi, Vasili Dimitrov, and Akiva Bar-Nun

Department of Geophysics and Planetary Sciences, Tel-Aviv University, Israel

e-mail: akivab@post.tau.ac.il

Since the descent of the Huygens probe in January 2005 and during the ongoing Cassini mission, a huge amount of data on Titan's atmosphere has been collected. Numerous hydrocarbon and nitrile species have been observed mainly unsaturated species: C_2H_2 , C_2H_4 , HCN and HC_3N with mixing ratios of about 3×10^{-6} , 10^{-7} - 10^{-8} , 3×10^{-7} and 10^{-9} - 10^{-10} respectively, reside in Titan's atmosphere between 150-500 km [Vinatier et al. 2009; Coustenis et al. 2007] as well as C_3H_4 , C_3H_8 , C_4H_2 , C_4H_4 , C_2N_2 and C_6H_6 . This research focuses on the chemical composition of Titan's aerosols, formed by UV photolysis of various mixtures of C_2H_2 , CH_4 , HCN and N_2 at temperatures of 300K and 200K under the conditions of Titan's mid-atmosphere. UV is the main energy source in the mid-atmosphere at 150-500 km from Titan's surface. The abundances of gas-phase species were found to be in very good agreement with the Cassini-INMS observations. Gas and solid phase species and polymers are produced, mostly PAHs, up to pyrene – $C_{20}H_{12}$ and cross-linked polyvinyls up to $m/e=881$ were observed. The atomic ratios were found to be C:H:N = 1:1:0.007(8), unsaturated hydrocarbons with very low nitrogen. These compounds settle in the newly discovered lakes of Titan.

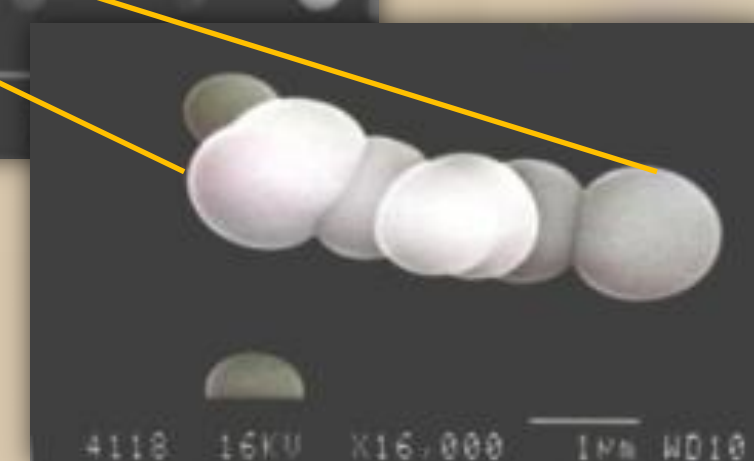
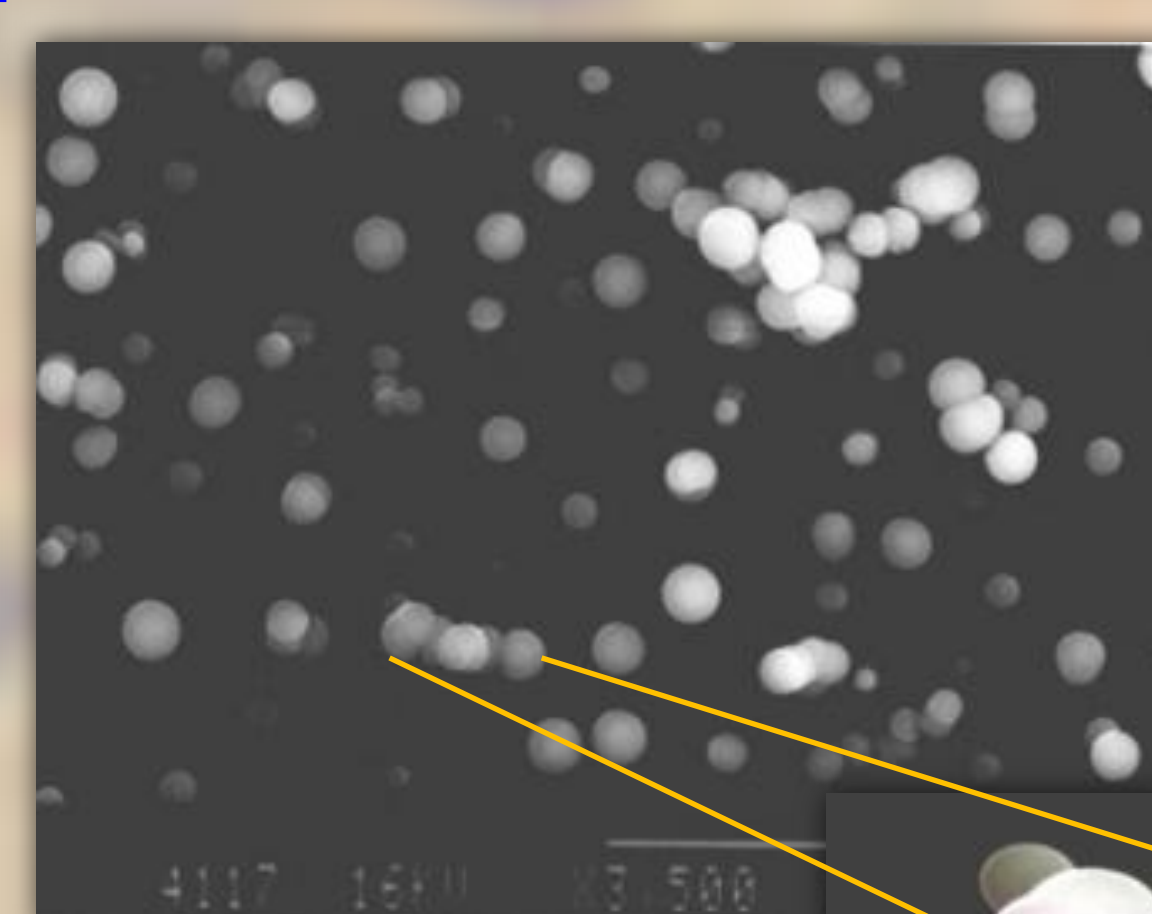
Comparison between the color of Titan and the experimental aerosols



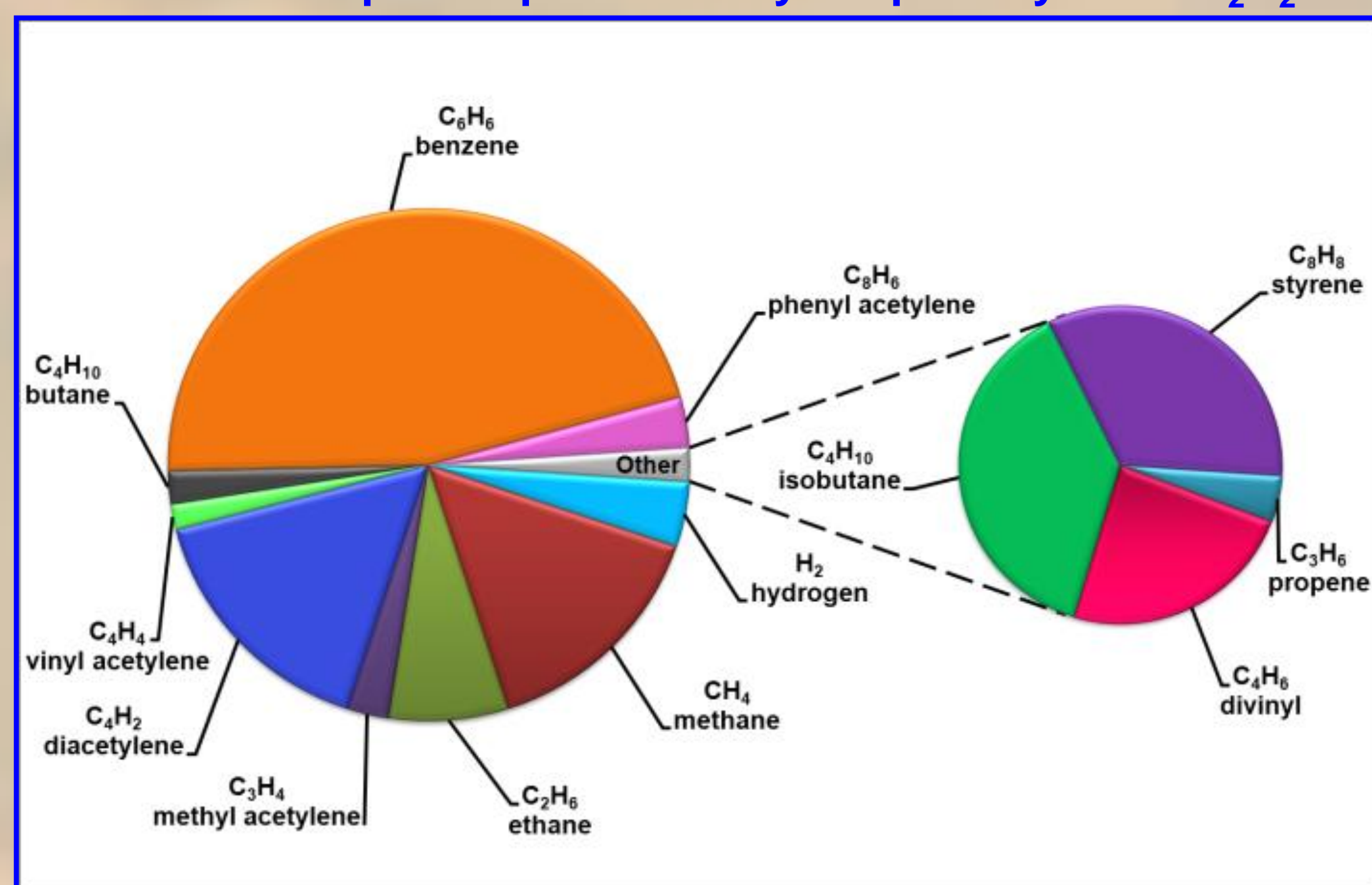
Titan's Haze



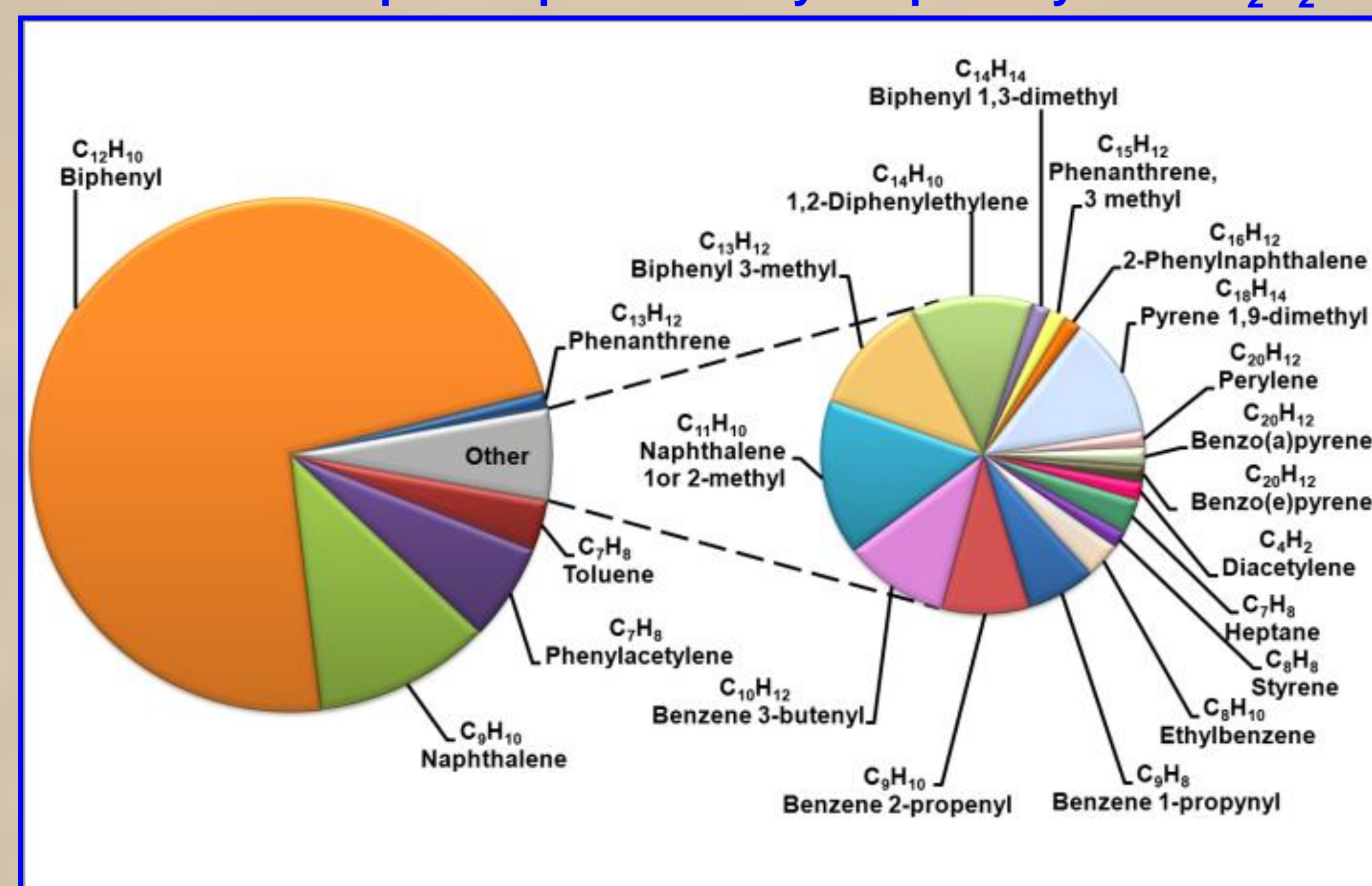
Experimental Aerosols



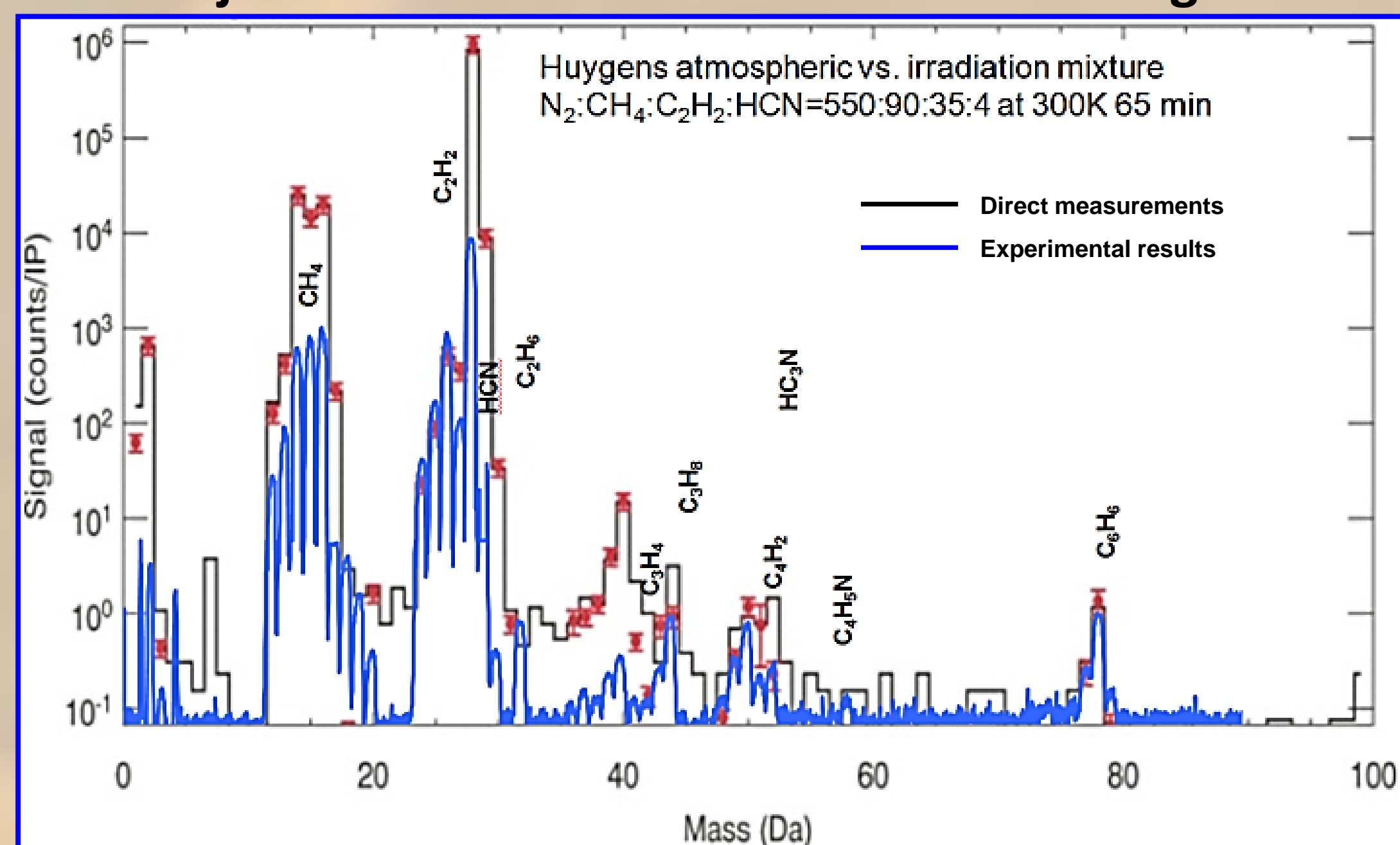
Gas Phase species produced by UV photolysis of C_2H_2



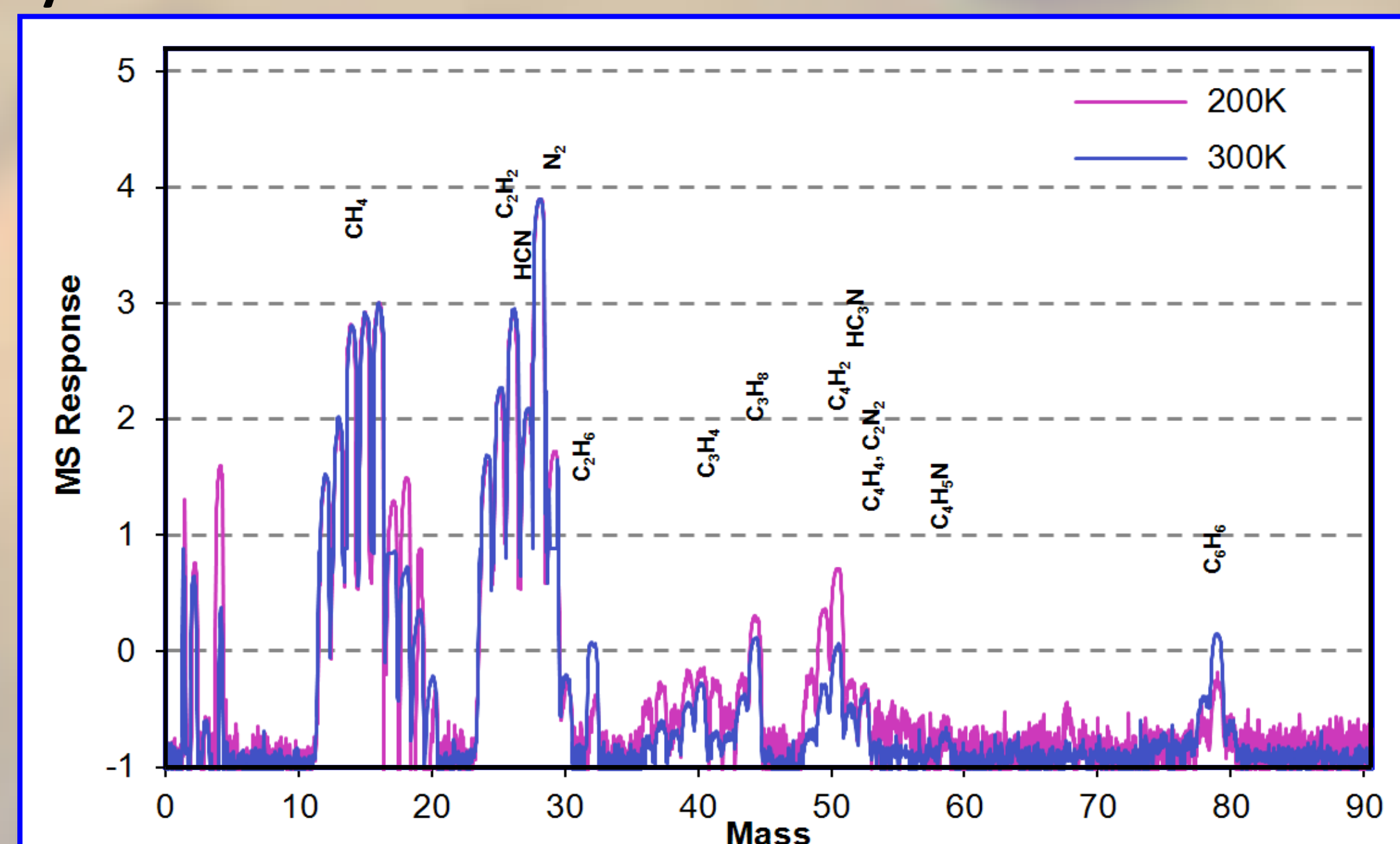
Solid Phase species produced by UV photolysis of C_2H_2



The main constituents in the gas phase are benzene, diacetylene, methane and ethane and up to C_8H_8 - styrene. In the solid phase, the main constituents are biphenyl, naphthalene and phenyl acetylene, up to the condensed 5-ring pyrene. Yet a major fraction consists of cross-linked long chains of polyvinyls.



Comparison between the experimental results of UV photolysis at 300K and Titan's atmospheric composition at 1174-1230 km from the surface, shows a very good agreement with the measurements of Huygens probe [Waite et al. 2005, 2007].



Comparison between the experimental mass spectrum of $CH_4:C_2H_2:HCN:N_2=90:35:4:550$ torr at 300K and 200K shows the same results.

The results were published in Jacovi, R., D. Laufer, V. Dimitrov, and A. Bar-Nun (2010), Chemical composition of simulated Titan's mid-atmospheric aerosols, J. Geophys. Res., 115, E07006, doi:10.1029/2010JE003585