

Photochemical activity of HCN-C₄H₂ ices in Titan's lower atmosphere. D. Dubois^{1,2}, M. S. Gudipati¹, N. Carasco^{2,3}, ¹Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA, ²LATMOS, Université Versailles St-Quentin, UPMC Univ. Paris 06, CNRS, 11 blvd d'Alembre, 78280 Guyancourt, France (david.dubois@latmos.ipsl.fr), ³Institut Universitaire de France, 103 bd Saint-Michel, 75005 Paris, France.

Abstract: Revealed by the Cassini and Voyager Missions, a plethora of volatile species are formed in Titan's upper atmosphere from the initial N₂/CH₄ (~98/2%) composition. As they precipitate, most of the volatiles condense in the colder lower atmosphere where they can form icy clouds (e.g. C₄N₂, HCN, C₂H₆) which have been detected above the poles. HCN is the most abundant nitrile in Titan's atmosphere and suspected to condensate in Titan's lower stratosphere (typically <100 km). Micron-sized HCN ice particles were also observed above the south pole at high altitudes (300 km). This cloud is thought to have been formed in the post-equinox winter polar vortex. In the north polar regions, HCN is also a likely prominent contributor to the *haystack* spectral signature seen at 221 cm⁻¹. These stratospheric ices may contribute as condensation nuclei for ices deeper down in the troposphere. Furthermore, C₄H₂, a simple alkyne formed by the chemistry and relatively abundant in the stratosphere, condenses near 75 km, lower than HCN. C₄H₂ can also absorb the lesser energetic photos at these low altitudes, forming the radical C₄H which then reacts with CH₄, causing the consumption of methane. Consequently, the loss mechanism for C₄H₂ is photochemistry. As soon as C₄H₂ condenses, small molecule and complex accretion with HCN may occur. The reactive state that these ices may undergo with long-UV radiation after they form is still largely unknown. We explore these conditions by studying HCN-C₄H₂ ice mixtures in the laboratory, by using the Titan Organic Aerosol Spectroscopy and chemisTry (TOAST) setup at JPL's Ice Spectroscopy Laboratory (ISL). These ices are then irradiated at long-UV wavelengths pertaining to these low-altitude regions at low-controlled temperatures. The residue is analyzed using long-IR absorption. Our results show a solid-state HCN consumption due to irradiation, to which C₄H₂ acts as a catalyst, indicating HCN ice particle ageing in the troposphere may be facilitated by more complex condensed nuclei.

Acknowledgments: This work is partly funded by NASA Solar System Workings Funding to Murthy Gudipati and the part of the work carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration. We are also grateful to the European Research Council Starting Grant PrimChem for funding (grant agreement no. 636829).