PROBING TITAN´S ATMOSPHERE WITH ALMA. J. Serigano IV[1,2], C. A. Nixon[1], M. A. Cordiner[1,2], S. B. Charnley[1], P. G. J. Irwin[3], N. A. Teanby[4], A. J. Remijan[5],[1]NASA Goddard Space Flight Center (joseph.serigano@nasa.gov), [2]Catholic University of America, [3]Oxford University, [4]University of Bristol, [5]National Radio Astronomy Observatory

Introduction: The advent of the Atacama Large Millimeter/Sub-millimeter Array (ALMA) has provided a new and powerful facility for probing the atmospheres of solar system targets at long wavelengths (84-720 GHz) where the rotational lines of small, polar molecules are prominent. In the complex atmosphere of Titan, photochemical processes dissociate and ionize molecular nitrogen and methane in the upper atmosphere, creating a unique richness of trace hydrocarbons. Further investigation of Titan's atmospheric composition and characteristics may provide insights into properties of the atmosphere of the early Earth, making Titan an extremely interesting target from an astrobiological standpoint.

Utilization of ground-based sub-millimeter observations of Titan has already proven to be a powerful tool to complement results from spacecraft observations. Observatories such as the Sub Millimeter Array (SMA) and IRAM (30-m and Plateau de Bure Interferometer) have demonstrated the detection of molecules such as CO, HCN, HC_3N and CH_3CN in Titanôs atmosphere, allowing the determination of vertical abundance gradients, and isotopic ratios of $^{13}C/^{12}C$, $^{15}N/^{14}N$ and $^{18}O/^{16}O$. More recently, the Herschel Observatory made the first detection of hydrogen isocyanide (HNC) in Titanôs atmosphere. ALMA's unprecedented spectral and spatial resolution at high sensitivity will dramatically progress the use of ground based sub-millimeter observatories for planetary atmospheres, allowing for deep molecular surveys that will facilitate the hunt for potential prebiotic molecules on Titan.

Titan and other Solar System bodies are often utilized by ALMA to obtain the absolute flux scale for the science target. After the 12-month proprietary period expires, data are made publicly available within the ALMA Science Archive, resulting in a wealth of short observations of Titan spanning ALMAôs lifetime. Recent ALMA studies have utilized this archive to present spectrally and spatially-resolved maps of HNC and HC_3N emission as well as the first spectroscopic detection of ethyl cyanide (C_2H_5CN) in Titanôs atmosphere. This talk will discuss early Titan science using ALMA, including the re-observation of species seen previously by SMA, IRAM, and Herschel, and show the capability of ALMA to spatially map the emissions of stronger molecular species. We will also discuss the search for new species and isotopes, with a focus on isotopic ratios from CO in Titan's atmosphere. We will compare our results to previous measurements for Titan and other values in the Solar System. General implications for the history of Titan from measurements of CO will be discussed.

References: [1] Marten et al. (2002), *Icarus*, 158, 532 [2] Moreno et al. (2005), *A&A*, 437, 319 [3] Moreno et al. (2011), *A&A*, 536, L12 [4] Gurwell et al. (2011) DPS Meeting #43, Nantes. [5] Cordiner et al. (2014), *ApJ*, 795, L30 [6] Cordiner et al. (2015) *ApJ*, 800**,** L14