MEASURING EVAPORATION RATES OF METHANE UNDER SIMULATED TITAN CONDITIONS A. Luspay-Kuti[1], F. C. Wasiak[1], V. F. Chevrier[1], D. G. Blackburn[1], L. Roe[1]. [1]Arkansas Center for Space and Planetary Sciences, University of Arkansas (Fayetteville, AR 72701 USA; aluspayk@uark.edu).

Introduction: Long before the arrival of the Cassini-Huygens mission, it has been suspected that Titan may host surface methane-ethane oceans or seas, based on the fact that ground-level conditions are near the triple point of these hydrocarbons, and the detection of methane in the atmosphere by Voyager [1]. Even though there are no oceans, Cassini data shows ample evidence for surface liquids. Some of the primary evidence for the presence of lakes are the radar-dark patches detected by the RADAR instrument poleward of about 70° N, consistent with a smooth, non-reflecting, absorbing surface. Cassini SAR images support the idea that the patches are indeed liquid, having a high emissivity and low dielectric constant. These facts along with the finding of the GCMS instrument on the Huygens probe that showed evidence of methane moisture in the near subsurface, indicative of precipitation some time in the past, support that liquids exist on the surface of present-day Titan.

Methane and other hydrocarbons on Titan are thought to display a cycle similar to the hydrological cycle on Earth. The unique surface morphology including dendritic channels, as well as hydrocarbon rains and clouds observed by the Cassini-Huygens mission (e.g. [2]), all indicate the presence of such a complex hydrocarbon cycle. The atmosphere provides an interacting medium for the evaporation of these surface hydrocarbon lakes, supposedly composed of methane to a large extent [3], [4].

In the present work we generated an environment similar to what is present on Titan in our simulation chamber, and determined the evaporation rate of liquid methane under conditions typical of Titan.

Experimental: The experiments were run in our Titan simulation module, installed in the Andromeda chamber (volume: 3.46 m^3), previously used for experiments on Mars [5]. At the beginning of the experiments, the chamber is filled up with N_2 gas to create an atmosphere similar to that on Titan. Temperatures characteristic for Titan are achieved by a continuous flow of liquid N_2, initially into a canister, then to the coils surrounding the temperature control box. Temperatures are constantly monitored via 8 "K" type and 2 "T" type thermocouples, positioned at different parts of the module. When the temperature gets to the required regime in specific areas within the simulation module, methane gas is introduced to the system and is condensed into a petri dish through a solenoid valve. A detailed description of our Titan simulation facility can be found in *Wasiak et al. 2011* [6].

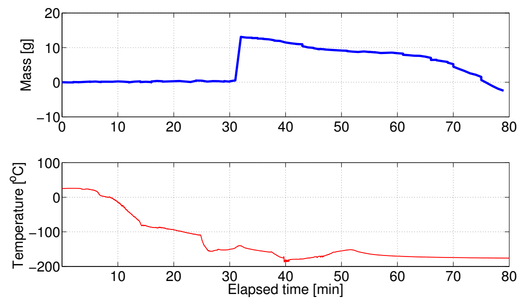

Figure 1: Mass of CH_4 and ambient atmospheric temperatures as a function of elapsed time. CH_4 was condensed and poured into the pan 31 minutes after the beginning of the run. Atmospheric temperatures were between 90-94 K from 40 to 44 minutes.

Once liquid methane has been made and poured into the pan, a scale connected to the system constantly measures the mass of methane. The scale is located near the top of the facility and is kept warm throughout the runs. All parameters are monitored and recorded continuously over the entire period of the simulation: a visual inspection is made possible by the web cam and video camera installed on the module, while all data is recorded and stored on a computer.

Evaporation rates are calculated by the change in mass over time, resulting from the evaporation of liquid methane into the N_2 atmosphere within the chamber.

Results: The top panel of Figure 1 shows the mass of CH_4 as a function of elapsed time during an entire run. The mass of methane decreases over time as a result of evaporation into the N_2 atmosphere. Values on the y-axis do not indicate absolute mass, instead the relative rate is determined. Methane was condensed into liquid and poured into the petri dish in the Titan module ~ 31 minutes after the beginning of the run. 12.61 g of liquid methane was made and

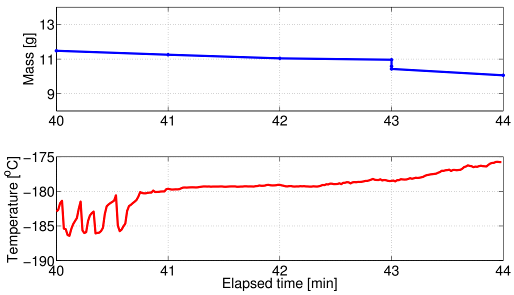

Figure 2: Magnified section of mass of CH_4 (top) and ambient atmospheric temperature (bottom) vs. elapsed time, when the temperatures were in a regime characteristic of Titan surface temperatures. Evaporation rates were calculated in this section.

the evaporation rate monitored. At the time of methane condensation, the atmospheric temperatures were lower than those typical of the surface of Titan. Continuous flow of liquid N_2 through the coils of the temperature control box lowered the temperature to about 88 K after about 35 minutes elapsed from the start of the recording.

Figure 2 shows the mass of liquid methane for the period when atmospheric temperatures were ideal with respect to Titan conditions. At these times, the temperature of the ambient atmosphere in the chamber 1 inch above the pan of evaporating liquid methane varied between 90 and 94 K. The evaporation rate of methane in this latter period results to be 0.284 g/min.

Evaporation rates for the rest of the run described here were not estimated, as temperature conditions were only ideal in the previously mentioned period. The increasing temperature near the end of the run speeds up the evaporation significantly, and so rates calculated over that period would not give meaningful results.

After the success of creating Titan conditions, condensing methane in the simulation module and measuring the evaporation rate of methane, further steps will be made to maintain the ideal temperature regime for a longer period of time over the course of the runs. We are also implementing a gas chromatograph to the system, and methane concentration will be measured by a flame ionization detector.

The present results and our future work provide valuable information about the evaporation rates of hydrocarbons under Titan conditions. Furthermore, they will prove useful when compared to theoretical models aimed at the stability of hydrocarbons on Titan and help determine more accurate parameters used in models, as well as help validate and revise them.

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References: [1] J. I. Lunine, et al. (1983) *Science* 222:1229. [2] T. Tokano, et al. (2006) in *European Planetary Science Congress 2006* 31–+. [3] E. R. Stofan, et al. (2007) *Nature* 445:61. [4] D. Cordier, et al. (2009) *ApJ* 707:L128. [5] D. W. G. Sears, et al. (2005) *GRL* 32:16202. [6] F. C. Wasiak, et al. (2011) in *LPS XLII,* Abstract submitted.