**A FACILITY FOR SIMULATING TITAN'S ENVIRONMENT.** F. C. Wasiak, A. Luspay-Kuti, D. G. Blackburn, L. Roe, V. Chevrier, Arkansas Center for Space and Planetary Sciences, University of Arkansas, Fayetteville, AR 72701 USA (fwasiak@uark.edu).

**Introduction:** Saturn's largest satellite Titan, with its thick atmosphere, clouds, polar lakes, and fluvial morphologies, indicates a complex "hydrological" cycle. However, unlike Earth's hydrological cycle which consists of one constituent, Titan's cycle may involve many constituents such as methane, ethane, and propane [1,2,3]. As a result of the measurements acquired by the Cassin-Huygens mission, Titan conditions can now be simulated in the laboratory and samples can subsequently be subjected to these conditions. To that end, we retrofitted our long-standing Mars simulation facility (the Andromeda chamber in the W. M. Keck laboratory for planetary simulation) to have the additional capability of simulating the surface and atmosphere of Titan. The primary goal of our research is to experimentally determine the short and long term stability of light organic volatiles at the surface and subsurface of Titan [4,5].

Experiments on the evaporation rates of methane, ethane, etc., and mixtures thereof will characterize diffusion through the $N_2$ atmosphere near the surface as well as through the uppermost few centimeters of simulated regoliths. Here we present the properties of our Titan simulation chamber.

**Andromeda simulation chamber:** Our chamber, as previously used by Sears *et al*. [6], is a stainless steel upright cylinder with an internal diameter of 61 cm and height of 208 cm. Access is through a hoist operated lid. A 10 cm outlet at the bottom of the chamber leads to a Kinney KDH (83 CFM) vacuum pump. A chiller operates by flowing antifreeze via a GE 1.5 HP pump through 52 meters of 1.27 cm copper tubing surrounding the chamber. The chamber is wrapped in ~20 cm of fiberglass insulation and is encased in an aluminum cabinet 1.2 m by 1.2 m by 2.4 m (Figure 1).

**Figure 1.** Andromeda Planetary Simulation Chamber

**Retrofit module for Titan conditions**: Our retrofit consists of a removable module that is placed within the Andromeda chamber, along with ancillary tubing and electrical connections (Figure 2). A simulated Titan atmosphere is achieved by filling with N2; methane or other sample liquids are then introduced as described below.

The Titan Module (TM) is a stainless steel structure that is lowered into the chamber via a hoist (figure 2.) The lower portion of the module is a cylindrical steel housing with a diameter of 53 cm and height of 53 cm. Contained within this housing is a Temperature Control Box (TCB) with a diameter of 36 cm and height of 38 cm. It rests on a small platform within the module and is surrounded by fiberglass insulation.

The TCB is surrounded by ~15 m of 0.95 cm 318L stainless steel coiled tubing through which liquid nitrogen (LN2) flows.

Residing within the TCB is a stainless steel condenser 8.9 cm in diameter and 28 cm in height. At the bottom of the condenser is a Valcor SV97 solenoid valve which, when opened, pours the condensed sample liquid into a pan where it is continuously weighed while the liquid evaporates, thus determining the evaporation rate under the simulated conditions.

The pan containing the liquid sample is located within the TCB, while the balance sits on a platform above the module's enclosure to prevent exposure to cryogenic temperatures. Braided fishing line connects the pan to the balance above. The line passes through ceramic tubing to minimize heat transfer between the TCB and surroundings.

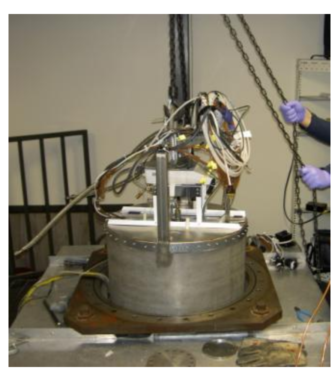

**Figure 2.** Titan Module being lowered into the Andromeda Chamber

Fitted around the condenser is a canister where LN2 is introduced via a bayonet. By regulating the amounts of LN2 in the canister and sample gas in the condenser, variable amounts of liquid can be condensed; this simple yet effective configuration yields the liquid sample desired. The liquid sample is subsequently poured into the sample pan via the solenoid valve (Figure 3).

**Figure 3.** Liquid methane pouring into pan. Pan is suspended from a scale and continuousely weighed

**Data Acquisition & Control System**: To maintain the module concept of the Titan experiments, our Data Acquisition and Control System (DACS) is a combination of the original Andromeda system coupled with the additional (and removable) Titan capabilities. The computer interface for the scale and pressure sensors, along with the thermocouples attached to the Andromeda chamber, are part of the original system, and data is acquired via LabView software. The Titan Module utilizes an Omega thermocouple data acquisition module and a Watlow EZ-Zone PM temperature controller operated via Specview software. The solenoid valve and all LN2 and gas inputs are operated manually.

**Discussion**: Titan relevant temperatures are initially achieved by continually flowing LN2 through the coils of the TCB and by the LN2 contained in the canister. Once the liquid sample is poured, the temperature is maintained by the continuous flow of LN2 through the coils. Thus far, the parasitic heat-losses of our system are sufficient that the Watlow temperature control system, with heater element, is unused; temperature is controlled manually by adjusting the LN2 flow through the coils. However, this does not allow for timely control, nor within the precision we desire (± 1° C). We are currently studying several options to improve temperature control.

To date all tests have been run at 1 bar as we continue with our system implementation. Pressure tests and leak checks are forthcoming, and subsequent tests will be run at the Titan surface pressure of 1.5 bar.

We will also be operating a gas chromatograph for hydrocarbon concentration measurements. Samples will be taken from several locations within the chamber and analyzed by a flame ionization detector.

**References:** [1] Cordier D. et al. (2009) *The Astrophysical Journal*, 707, L128-L131. [2] Hayes A. G. et al. (2010) *Icarus,* doi:10.1016/j.icarus.2010.08.017. [3] Mitri G. et al. (2007) *Icarus*, 186, 385-394. [4] Brown R.H. et al. 2008 *Nature*, 454, 607-610. [5] Hayes A. et al. (2008) *Geophysical Research Letters*, 35, 9204-9208. [6] Sears D. W. G., Moore S. R. (2005) *Geophysical Research Letters*, 32, L16202.

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