LABORATORY EXPERIMENTS TO STUDY THE MARTIAN WATER VAPOR CYCLE.
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Introduction: Ice, adsorbed water, and liquid brines [1-5] are potential reservoirs of water at the surface and in the shallow subsurface of Mars. As the surface of the planet is warmed by solar irradiance during the day, shallow reservoirs can be volatilized and might represent a significant source of water vapor to the Martian atmosphere [1]. We have constructed an environmental chamber [6] capable of simulating the atmospheric pressure, temperature, humidity and the solar irradiance at the surface to investigate the exchange of water between these reservoirs and the atmosphere. Here we present preliminary results on the quantification of the exchange of water between the surface and the atmosphere [7]. This research has the potential to shed light on the diurnal and seasonal variations of the near surface reservoirs of water on Mars.

Experimental Description: We have designed and built an environmental chamber to simulate the conditions at the Mars Phoenix landing site, including diurnal and seasonal cycles. The system consists of a vacuum chamber with internal thermal plates, which can be cryogenically cooled using liquid nitrogen. Additional thermal control is performed using resistive cartridge heaters embedded in the thermal plates. The vacuum chamber inlet is connected to a carbon dioxide dry gas stream, which can be throttled to control the chamber’s humidity. The vacuum chamber outlet passes through a chilled mirror hygrometer to measure the chamber humidity. A Raman spectrometer and a microwave soil moisture sensor [8] are used to measure the soil hydration state and wetness profiles.

Sample Volume: 30 cm x 30 cm x 30 cm
Atmospheric Pressure: 10 Pa to 10^5 Pa
Water Vapor Pressure: 0.05 Pa to 45 Pa
Temperature: -170 °C to 230 °C
Temperature Cycle Time: Hours to Days
Solar Simulation: UV to near-IR

Fig 1. (Left) The environmental chamber, (Right, top) a small sample holder with 250 mL soil sample, and (Right, bottom) the microwave soil moisture sensor, which rests above the soil sample.