EXPERIMENTS WITH CARBON DIOXIDE ICE AT MARTIAN POLAR CONDITIONS I. B. Smith[1], R. Karimova[1], J. Isen[1]. [1]York University, 4700 Keele St, Toronto, ON, Canada,

Introduction: The polar regions of Mars experience deposition of seasonal carbon dioxide ice in each respective winter that sublimates during spring and summer [1, 2]. The ice caps, known as the north and south polar seasonal caps, respectively, undergoes transformations in density and albedo as it metamorphoses due to thermal gradients caused by heat released from the substrate and from insolation. Outside of the polar night, sunlight may pass through the ice to warm the substrate, which warms the ice from below, potentially creating gas pockets that can pressurize enough to fracture the ice and entrain dust or sand to be scattered on the surface of the ice. This process of forming jets and fans is called the "Kieffer Model", and our experiments that fracture the ice are able to constrain the thermal gradient required to create it [3].

Methods: In our experiments, we recreate the conditions of the south pole of Mars, ~6 mbar and ~140 K, in the MARs Volatile and Ice evolutioN (MARVIN, Figure 1) chamber at York University in Toronto. Our experiments identify several phases of CO_2 ice, including bright frost and transparent ice (Figure 2), similar to [4]. We also observe crystalline structure in microscopes. We use reflectance spectroscopy, at 0° phase and with a home built goniometer to have +/- 60° incident and reflected light to develop bidirectional reflectance distribution functions (BRDFs) for each phase.

Results: Finally, we test various hypotheses related to the seasonal increase in albedo of the south polar residual cap that is not observed at the north polar residual cap [5]. In the first scenario, internal fracturing scatters the sunlight, brightening the signal that returns to orbital cameras. In the second scenario, the surface of the ice has large facets that give rise to specular reflection of incoming solar radiation. This second scenario requires increasing surface pressure, a condition met at the south pole during southern spring but not met during northern spring. We observe these facets and surface brightening in our experiments that increase in surface pressure, supporting the second hypothesis, and possibly explaining the polar dichotomy.

References: [1] Calvin, et al. Icarus 292, 144–153. [2] Calvin et al. Icarus, Dynamic Mars 251, 181–190. [3] Kieffer, H.H., 2007. J. Geophys. Res. 112, E08005. [4] Portyankina et al. 2019. Icarus 322, 210–220. [5] Byrne et al. 2008. Planetary and Space Science 56, 194–211.

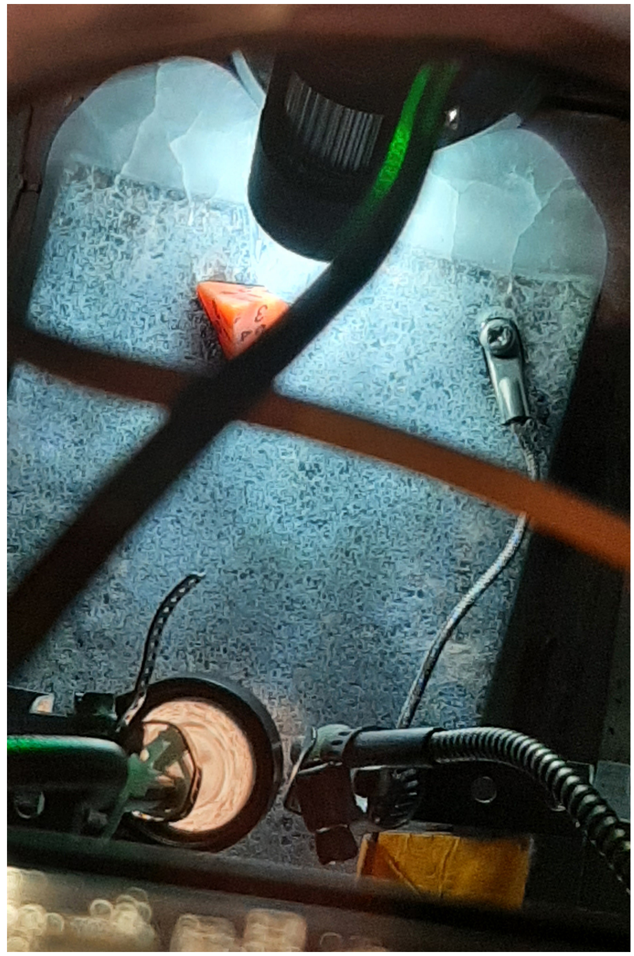

Figure 2: Growing frosted CO_2 ice in the MARVIN Chamber. Visible are the black-coated cold plate with frosted white CO2 ice on the surface; thermocouple; goniometer arms, and an orange tetrahedral die for scale. We create various textures at various conditions.

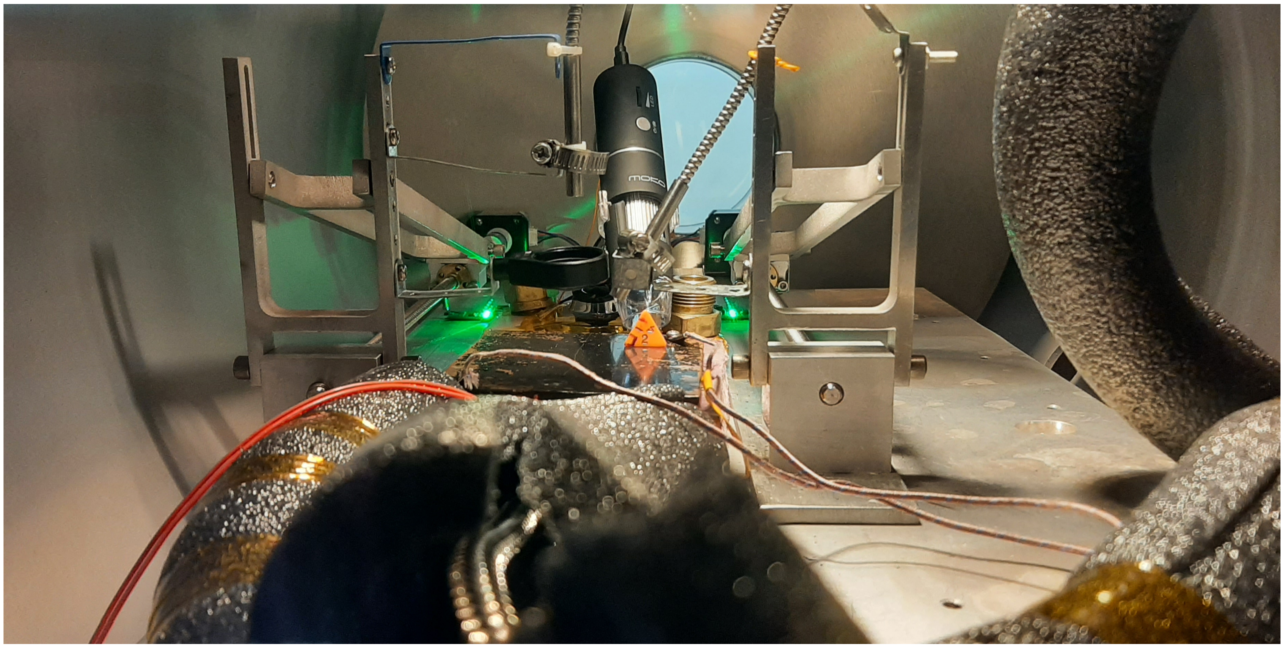

Figure 1: Interior of the MARs Volatile and Ice evolutioN (MARVIN) Chamber. Black insulation covers the liquid nitrogen lines; a black plate acts as the surface for CO_2 ice deposition; goniometer arms move towards and away from the camera in order to measure the principal plane of the bi-directional reflectance distribution function (BRDF). The chamber is 60 cm in diameter and ~1 m long. Several ports allow for thermocouples, fiber optic cables, USB ports, and other electrical feedthroughs.