Comparison of Seasonal Temperature Variations, Albedo Variations, and Sublimation Activity for CO$_2$ ice and H$_2$O ice Near the Martian South Pole. Paras Angell$^1$ and P. R. Christensen$^1$, *Mars Space Flight Facility School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287. Email: Paras.Angell@asu.edu

**Introduction:** The Martian south polar cap is a dynamic region covered with a seasonal layer of CO$_2$ ice and some H$_2$O ice. Every spring and summer dramatic changes transpire as the CO$_2$ sublimes. The sublimation is accompanied by distinct surface processes in different south polar regions. In the 'cryptic terrain' [1], dark spots and streaks form on the surface due to basal sublimation of the CO$_2$ ice slab [1, 2]. Near the edge of the perennial southern polar cap an exposed H$_2$O ice unit [3] is revealed after the seasonal CO$_2$ ice layer sublimes.

This project investigates the seasonal temperature variations and albedo variations in these two Martian south polar regions with the goal of understanding the CO$_2$ sublimation processes and the differences between regions covered with H$_2$O ice and CO$_2$ ice.

**Methods:** The two regions studied are shown in Figure 1. In the Manhattan region, centered near 86° S, 99° E in the cryptic terrain, the areas of interest are labeled A1, A2, A3 (Figure 2). In an exposed water ice region, centered near 85° S, 10° E, the areas of interest are labeled A4, A5, A6 (Figure 5).

Visible images taken by the Thermal Infrared Imaging System (THEMIS) [5] were examined to study the progression of CO$_2$ sublimation activity during spring and summer. Average albedo values for each area were calculated from the calibrated THEMIS visible albedo products [5].

THEMIS infrared (band 9) images (Figure 5) were analyzed using JMARS software [6] to calculate the average surface temperature for each area. Surface temperatures were studied as a function of solar longitude (Ls) for Mars years 30, 31, 32, and 33.

**Results:** During early spring at Ls 175° the Manhattan region the surface is covered with CO$_2$ ice, with a surface temperature of ~140 K. There are many dark spots on areas A2 and A3, but very few on A1.

Figure 2 shows a visible image taken at Ls 213°. Area A1 has some dark spots, while area A2 has many dark streaks oriented towards the west. A3 seems to be covered with a layer of dark material. The surface temperatures have warmed up to around 160 K.

Figure 3 shows variation of average surface temperature for Mars year 31 showing the sharp rise in temperature at Ls 250°.

Figure 3: Average surface temperatures for areas A1, A2, A3 as a function of Ls for Mars year 31 showing the sharp rise in temperature at Ls 250°.
Figure 4 shows how the visible THEMIS albedos for areas A1, A2, and A3 vary with solar longitude for Mars year 32. The albedo of the scene decreases as spring progresses. Albedo values increase again and peak around Ls 245°, which correlates with the beginning of the sharp rise in temperatures at that Ls. The variation of albedos with solar longitude for Mars year 33 has a similar trend.

In the exposed water ice region, in early spring all areas are covered with a continuous layer of CO₂ ice, and have the same temperature ~150 K at Ls 204°. Figure 5 shows an infrared image taken at Ls 337°, in late summer after the crocus date. Three thermally distinct units are revealed. A4 is colder than A5, and A6 is significantly warmer than both A4 and A5. The boundaries between units are observed to be stable over several Mars years.

Figure 6 shows how the average surface temperature changes with solar longitude. After Ls 280°, the surface temperatures differentiate between three units: CO₂ ice, H₂O ice, and regolith. H₂O ice has an intermediate albedo between those of CO₂ ice and regolith. Area A5 is identified as H₂O ice [3] based on its temperature (190 ± 3 K) and higher albedo than regolith. Future work will include detailed analysis of THEMIS albedo products, investigating other areas outside the cryptic region, and exploring the extended water ice region.