SEASONAL TEMPERATURE MODELING OF NEAR-SURFACE ICE ASSOCIATED WITH GLACIAL FEATURES IN THE HELLAS BASIN REGION ON MARS. A. M. Rutledge and P. R. Christensen. School of Earth and Space Exploration, Arizona State University, Tempe, AZ; alicia.rutledge@asu.edu

Introduction: Geologic features on Mars show clear evidence of modification by water and water ice [1-5]. Past obliquity variations have been theorized to have promoted the formation and stability of ground ice near the equator, possibly promoting the accumulation of glaciers and the subsequent formation of periglacial terrain [6-8].

Hellas Basin, with a diameter of ~2000km and a floor 4-6km below the surrounding terrain, is centered at 45°S, 290°W and dominates the southern cratered highlands of Mars [9]. The basin was formed over 4 b.y. ago by the impact of a low-angle bolide, causing an asymmetrically distributed uplifted rim [10].

Lobate debris aprons, tongue-shaped lobes, hourglass craters containing flow features, and ice-cemented mantling deposits at the heads of gullies have been documented on the eastern rim of Hellas Basin (Figure 1) [8-9,11-12]. High-resolution imagery has shown concentrically ridged lobate and pitted features on the lobate debris aprons, indicating both glacier-like viscous flow and probable ice sublimation [13-14]. Evidence for thick layers of solid ice within these lobate debris aprons was recently found through radar sounding by the Shallow Radar (SHARAD) on the Mars Reconnaissance Orbiter [15]. These features are thought to have formed from atmospheric precipitation of water ice during the Amazonian [8, 16].

These fairly young glacial and periglacial features suggest that a significant amount of near-surface ice may remain within the deposits today, making the region an important site for future studies of the martian climate and geologic history, studies of the regional and global water distribution, and the search for extraterrestrial life.

Thermal Ice Model: Much of the surface of Mars has thermal properties consistent with a high thermal inertia layer (possibly ice-rich rocky material) covered by a few centimeters of low thermal inertia material (dry particulate regolith) [17-18]. Surface cover thermal inertia models have been used to predict the depth to present-day ice in the shallow subsurface of Martian high latitudes using Thermal Emission Imaging System (THEMIS) and Thermal Emission Spectrometer (TES) data [18-19]. The temperature response of the surface cover is dependent on the intensity and period of the input solar cycle as well as the thermophysical properties of the material itself. The skin depth, or thickness of the surface layer influenced by the energy cycle, is proportional to the square root of the period of the cycle. Thus, a longer cycle allows properties at a greater depth to be determined (i.e. seasonal variations in surface temperature allow meter-scale depth calculations.)

Seasonal differences in surface temperatures have been used to gain insight into the relative thermal inertias of the surface layers and the relative depth of an assumed high-inertia subsurface layer (i.e. ice-rich material) [18]. The thermal inertia of the surface layer dominates surface temperatures during the martian summer (solar longitude L\textsubscript{s} ~100°-180°) and the depth to the ice layer dominates the change in relative surface temperatures between summer and fall. Thus, quickly-cooling surfaces have a deeper ice layer, and more slowly cooling surfaces have a shallow ice layer. Differences in THEMIS temperature data have been used to predict ice layer depth and distribution at high resolution (100m/pixel) [18].

Near-surface ground ice modeling. This thermal model was applied to a lobate debris apron complex shown in Figure 2 using THEMIS nighttime infrared imagery. Results indicate that a shallow layer of ground ice is present near the surface of the apron and the surrounding plains. An ice table map is shown in Figure 2. These results are consistent with regional water ice estimates made by the High Energy Neutron Detector [20]. Results from SHARAD indicate a thick layer of massive water ice buried within this particular lobate deposit by a <10m thick debris layer [15]. As differences between the apron and the surrounding plains are not readily apparent (Figure 2), our results indicate a regional ice table present in the debris above this estimated layer. The thermal signature of the proposed buried massive water ice deposit is not immediately detected, indicating that this deposit, if present, is at a depth of >20 cm.


Figure 1: Location of major lobate debris apron (LDA) complexes on the eastern rim of Hellas Basin, indicated by blue shading. The LDA of interest to this study is located within the red box. Background is from the Mars Orbiter Laser Altimeter global map [21].

Figure 2: Lobate debris apron surrounding a massif on the eastern rim of Hellas Basin, shown in THEMIS daytime infrared imagery [21]. Inset: Ice depth map centered near 44.5S, 105E. Modeled temperatures indicate that cool colors are consistent with a shallow ice table (<1-3 cm) and warm colors are consistent with a deeper ice table (>20 cm). Slightly deeper ice depths (shown in green) are often associated with talus slopes, indicating deeper burial by gradation of the massif material. No major differences in ice depth are observed when comparing the lobate deposit to the immediately surrounding plains.