HETEROGENEITY OF ICE IN LUNAR PERMANENTLY SHADOWED REGIONS. D. M. Hurley[1], R. C. Elphic[2], and B. Bussey[1], [1]Johns Hopkins University Applied Physics Laboratory (11100 Johns Hopkins Rd., Laurel, MD 20723; dana.hurley@jhuapl.edu), [2]NASA Ames Research Center (Moffett Field, CA 94035).

Introduction: Some future lunar missions will need detailed information about the distribution of volatiles in lunar permanently shadowed regions (PSRs) for either scientific or exploration purposes. However, it is unlikely that the distribution will be known *a priori* with enough spatial resolution to guarantee access to volatiles using a static lander. Some mechanism for mission mobility will be necessary to ensure access to volatiles. Thus, we examine the data regarding the spatial distribution of volatiles in lunar PSRs and couple those with models of smaller scale processes. We present findings regarding the heterogeneity of volatiles in PSRs. These results can be used in trade studies to determine the necessary range and duration of missions to lunar PSRs that can be anticipated in order to accomplish the mission objectives.

Impact Gardening Model: We use a Monte Carlo technique to simulate the stochastic process of impact gardening on a putative ice deposit [1-4]. By conducting multiple runs with the same initial conditions and a different seed to the random number generator, we are able to calculate the probability of situations occurring. This technique will never be able to reproduce the exact impact history of a particular area. However, by repeating the simulations with varied initial conditions, we calculate the dependence of the expectation values on the inputs.

The model uses the crater production function as a basis for generating impact craters over time [5-6]. The model explicitly follows a volume of regolith 20 m x 20 m x 5 m deep. However, impacts are generated over a larger area as some impacts centered outside of the box still contribute to the interior of the box. Thus the impact generation box is larger than the simulation box. The model implements impacts by calculating a bowl shape crater of the size and coordinates determined by the progam. The code alters the topography within the crater by replacing the existing topography with the new bowl at an altitude centered on the previous average altitude of the area. An ejecta blanket is deposited with a distance-dependent thickness overlying the pre-existing topography outside of the rim. The program modifies the volatile content and depth distribution resulting from the impact and then repeats the process for all of the impacts generated in the specified time window.

Data Sets: We compare data from PSRs that indicate the average surface distribution (FUV, laser) with data indicating distribution at depth (neutrons, radar, thermal).

Optical observations can only reveal the ice content of the extreme surface [7-10]. This population of ice can have two possible origins: 1) ice that is part of a continual delivery process that is ongoing on the Moon; or 2) ice that has recently been placed on the surface from an impact event that excavated ice that was buried below the surface. If the surface volatiles are part of an ongoing delivery, one would expect a rather uniform distribution throughout lunar PSRs. If the surface volatiles are from a recent exposure event, one would expect a more heterogeneous distribution. This can be calculated with the model.

Radar data suggest there are regions consistent with the presence of relatively pure ice, mainly in small PSRs distributed throughout the north polar region [11-13]. The model is applied to determine the fraction of filled small PSRs that would suffer a disruption event over time. This is compared to the fraction of PSRs with a significant radar CPR.

Neutron data provide additional insight into the depth distribution of hydrogen-bearing constituents of lunar PSRs [14-16]. We consider those data in conjunction with the model to understand the full, 3-D nature of the heterogeneity.

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