LUNAR COLD SPOT PROPERTIES AND DEGRADATION. T. M. Powell[1], B.T. Greenhagen[2], S. Taylor[1], J.-P. Williams[1], P.O. Hayne[3], and D. A. Paige[1], [1]Earth, Planetary, and Spaces Sciences, University of California, Los Angeles CA, 90095, USA (tylerpowell@ucla.edu), [2]Johns Hopkins University, Applied Physics Laboratory, Laurel MD, USA, [3]U. Colorado, Boulder CO, USA.

Introduction: Thermal mapping by the Diviner instrument on-board the Lunar Reconnaissance Orbiter [1] has identified a class of thermal anomalies called lunar cold spots. These are regions of reduced nighttime temperature surrounding many and possibly all of the youngest impact craters on the Moon [2]. Previous work has shown that these features can be explained by a 'fluffing-up' of the upper centimeters of regolith, resulting in a layer of lower thermal inertia material. This is typically characterized by the H-parameter, which in exponential folding term describing the rate of regolith density increase with depth where higher H-parameter corresponds to lower thermal inertia [3].

Individual cold spots can be found with varying degrees of H-parameter intensity. Additionally, not all young rocky craters still have cold spots. This suggests that cold spots are ephemeral features which degrade more quickly than the rocky material in the crater and continuous ejecta of new impacts.

The purpose of this work is to understand the spatial properties of cold spots and their degradation timeline. This can be helpful in understanding the space weathering and regolith gardening processes which likely cause their degradation.

Methodology: The recently published global H-parameter map [3] allows for more accurate cold spot identification than was possible using previously published nighttime temperature maps because of corrections for topography. We performed a survey of an equatorial swath from -10° to 10° latitude, with a focus on the identification of both faded and prominent cold spots. These cold spots were characterized by fitting the radial H-parameter profile to a function of the form: $H = A\left[1-\left(1-e^{-B(r-r_c)}\right)^2\right]$ where A is an amplitude term that describes the maximum intensity of the cold spot relative to background, r_c describes the radial distance to this maximum, and B describes the width of the cold spot.

Cold spots were grouped into four classes based on their H-parameter intensity. The crater size-frequency distributions of these classes were used to estimate the age of each population and obtain an approximate degradation timeline.

Results and Discussion: Our survey identified roughly 1500 cold spots within the evaluated region. This is a 4 fold increase over previous catalogues mostly due to the identification of smaller and more faded cold spots. H-parameter intensity ranges from 0.017 m to 0.15 m above background levels and crater diameter ranges from 20 m to 1.9 km. Interestingly, relative cold spot size shows no significant trend with degree of fading or crater diameter. Cold spots extend to about 50 crater radii regardless of crater size or cold spot intensity. One possible interpretation for this fading behavior is that high H-parameter, loosely packed regolith at the cold spot maximum is more fragile than lower H-parameter regolith near the cold spot edge, leading to different fading rates spatially based on H-parameter. However, a more complete understanding of the degradation mechanism is necessary.

The catalogued cold spots were categorized into four classes, shown in Figure 1. Figure 2 shows the cumulative crater frequency distribution of each class fit to Neukum production function isochrons at 250 m crater diameter [4]. These results indicate that the most intense cold spots of this size are less than ~8 ka and most fading occurs over timescales of ~130 ka.

Roll-off in cumulative crater frequency occurs at roughly 100 m crater diameter. This is largely a resolution effect, as cold spots smaller than this are difficult to identify using Diviner. Above this size the cumulative crater frequency data has a shallower slope than the Neukum production function. Larger craters deviate from the isochron towards older times, indicating that there are more large craters than would be predicted if intensity represents age. This suggests that cold spot intensity depends both upon age and crater diameter. This is consistent with findings from Williams et al. [5] which found that the largest cold spots with crater diameters >800m have ages between 200 ka and 1 Ma. It is possible that larger craters form higher intensity cold spots initially or are more resistant to degradation.

References: [1] Paige D. A., et al. (2010) *Space Sci. Rev.* 150, 125-160. [2] Bandfield J. L., et al. (2014) *Icarus*, 231, 221-231. [3] Hayne P. O., et al. (2018) *J. Geophys. Res: Planets*, 121. doi: 10.1002/2017JE005387. [4] Neukum G. et al. (2001) *Space Sci. Rev.* 12. [5] Williams J. P. (2018) *LPSC XLIX,* Abstract #2275

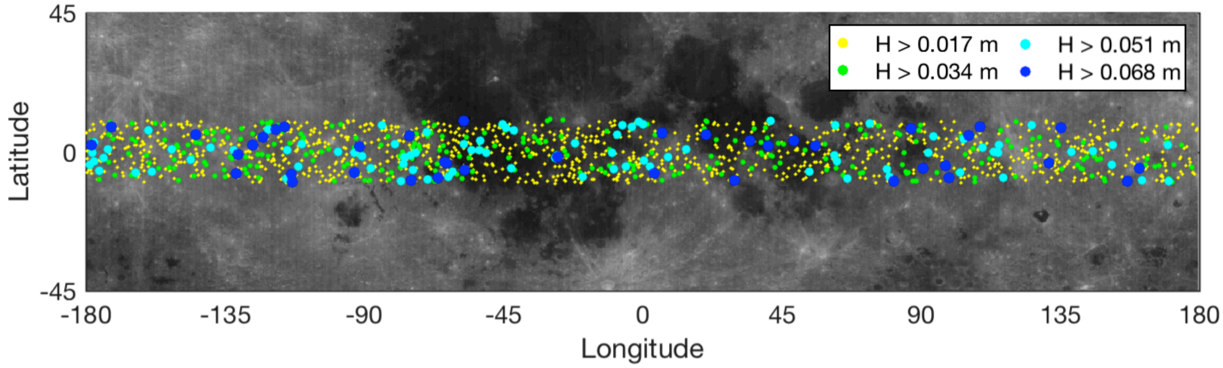
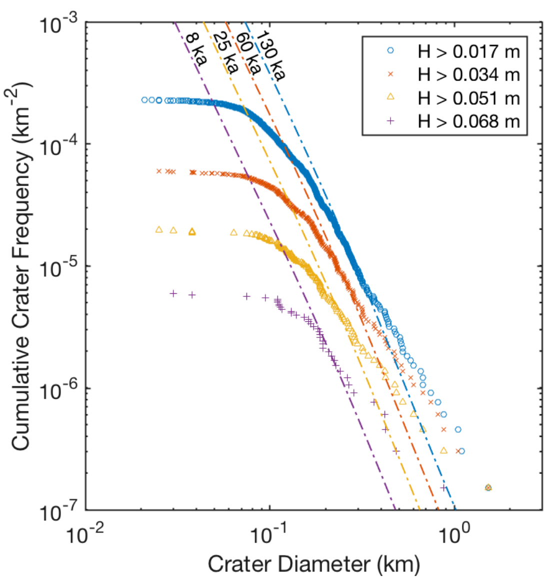


Figure 1: Catalogued lunar cold spots between +/- 10˚ latitude. Colors and marker size represent cold spot intensity, with yellow markers corresponding to faded cold spots and blue markers corresponding to intense cold spots.



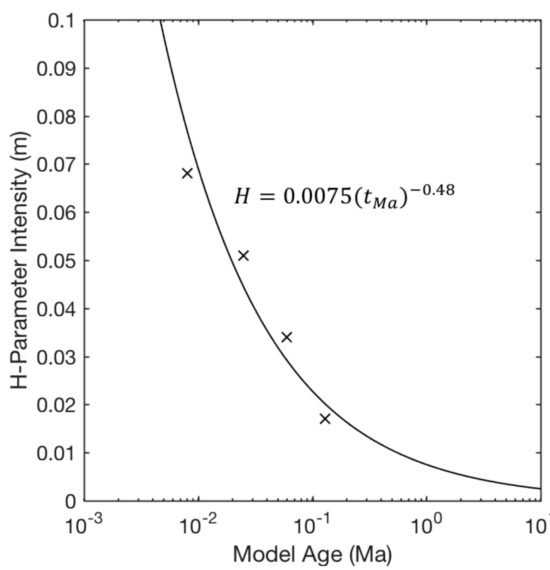


Figure 2 (left): Crater size frequency distribution for catalogued cold spots grouped based on their intensity. Neukum production function isochrons are fit at 250 m crater diameter.
Figure 3 (right): Cold spot degradation timeline for cold spots with ~250 m crater diameter.