NEW HIGH RESOLUTION POLAR TOPOGRAPHIC PRODUCTS FROM THE LUNAR ORBITER LASER ALTIMETER (LOLA). M. K. Barker[1], E. Mazarico[1], D. E. Smith[2], X. Sun[1], M. T. Zuber[2], G. A. Neumann[1], J. W. Head[3]. [1]Solar System Expl. Div., NASA Goddard Space Flight Center, 8800 Greenbelt Rd. Greenbelt, MD 20771 michael.k.barker@nasa.gov, [2]Dept. of Earth, Atmos. and Planet. Sci., MIT, 77 Massachusetts Ave. Cambridge, MA 02139, [3]Dep. Earth, Env. & Planet. Sci., Brown Univ., Providence, RI, 02906, USA.

Introduction: NASA plans to send robotic and human explorers to the south pole of the Moon in the next 5 years. These missions require accurate, precise, and high-resolution maps of surface height and slope both *outside* and *within* permanently shadowed regions on lander-relevant scales [1-5]. To that end, we have been creating new high-resolution (5 m/pix) topographic models of high-priority south pole sites based only on laser altimetry data acquired by the Lunar Orbiter Laser Altimeter (LOLA) onboard the Lunar Reconnaissance Orbiter (LRO). Imaging-based techniques, such as stereo [6] and shape-from-shading [7], face challenges in the polar regions due to the extreme shadowing conditions prevalent there. LOLA is not hindered by shadows, but by gaps between tracks and laser spots which require interpolation to fill in. Indeed, near the south pole, ~90% of LOLA digital elevation model (LDEM) 5 m pixels are interpolated. Moreover, small errors in the LRO orbit reconstruction (~ a few m horizontal & ~0.5 m vertical) can cause artifacts in hillshade renderings at 5 m/pix (Fig. 1a). Analyzing and mitigating these issues are two of the primary goals of this work [8], in which new LOLA track adjustment and improvement techniques, similar to those applied in [2], reduce the ground track geolocation uncertainty by over a factor of 10. These new LDEMs (available from [9]) are substantially improved over previous versions (e.g., Fig. 1b) and are more useful to constrain higher-resolution topographic models derived from imaging [6,7]. A major advantage of this process is that, for the first time, we can estimate realistic LDEM height uncertainties and their effect on illumination conditions. We developed a method to estimate surface height uncertainty that circumvents the infeasible computation of the full LDEM error-covariance matrix. Instead, we use the fractal nature of lunar topography to build a more computationally manageable statistical ensemble of 100 "clones" with similar error properties as the data. We use this ensemble to study height and slope uncertainty, and the uncertainty in illumination conditions. Such an approach can also be useful for a range of other characteristics, in addition to illumination conditions, when examining the feasibility of potential landing sites.

References: [1] De Rosa, et al. (2012). *PSS*, 74, 224. [2] Gläser, P., et al. (2014). *Icarus*, 243, 78. [3] Gläser, P., et al. (2018). *PSS*, 162, 170. [4] Heldman, J. L., et al. (2016). *Acta Astron.*, 127, 308. [5] Mazarico, E., et al. (2011). *Icarus*, 211, 1066. [6] Henriksen, M. R., et al. (2017). *Icarus*, 283, 122. [7] Alexandrov, O. & Beyer, R. A. (2018). *Earth & Space Sci.*, 5, 652. [8] Barker, M. K., et al. (2021). *PSS*, 203, 105119, 10.1016/j.pss.2020.105119. [9] https://pgda.gsfc.nasa.gov/products/78.

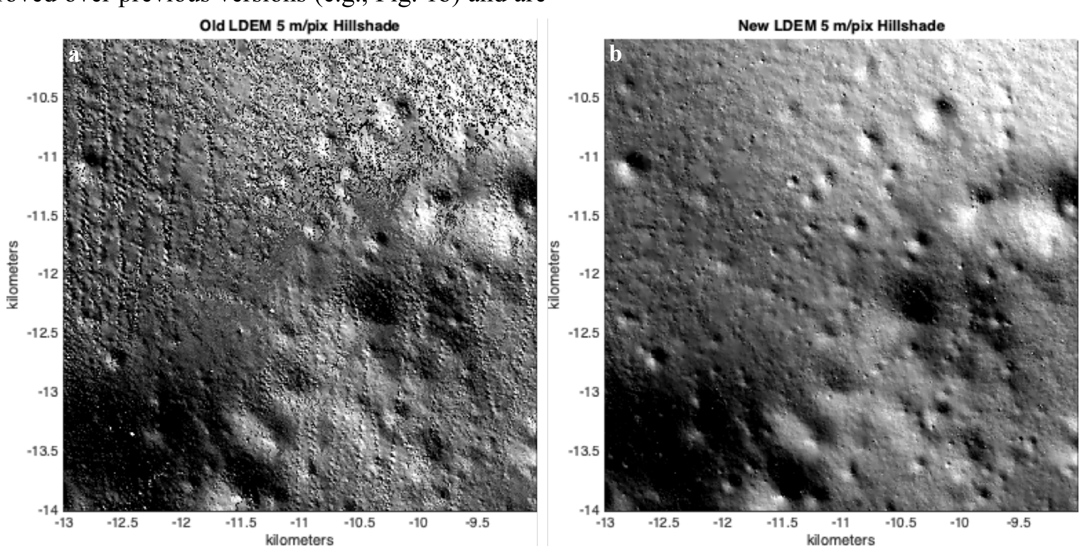

Figure 1 - 2x2 km region centered on Shackleton Ridge (Site 01 in [5,8]) before (a) and after (b) track adjustment and reprocessing. See [8] for further details and [9] for new LDEMs.