ILLUMINATION CONDITIONS OF THE LUNAR POLES FROM LUNAR ORBITER LASER ALTIMETER DATA.

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Introduction: Although diurnal temperature variations over most of the Moon's surface can be extreme, the lunar polar regions have the potential to trap volatiles in permanently shadowed regions (PSRs). Because the Moon's spin axis is nearly perpendicular to the ecliptic plane, the Sun is always low on the horizon in the polar regions, and topographic relief such as impact craters can be sufficient to provide permanent shadow. Although the Moon obliquity has been larger in the past, many PSR regions have likely been stable over tens to hundreds of millions of years. This was recognized before good topographic knowledge of the polar regions existed **[1]**, and was confirmed by more recent studies using ground-based radar **[2]** or spacecraft data **[3,4,5,6]**.

Data: We use data collected by the Lunar Orbiter Laser Altimeter (LOLA) instrument **[7]** onboard the Lunar Reconnaissance Orbiter (LRO) **[8]**. With more than 3.4 billion LOLA altimetric measurements (as of January 31, 2011), and the polar orbit of the LRO spacecraft, the data coverage of the poles is excellent. We construct topographic maps of the lunar polar regions, from ~75° to the pole, at a resolution of 240 meters per pixel. The map filling ratios are 68.8% and 67.6% in the north and south, respectively, and will continue to improve as the LRO mission progresses.

Method: The horizon method was described in detail in **[6]**. Horizon (angular) elevation maps are constructed for the region of interest (~80°-90°) for 720 azimuthal directions ($\delta\theta$=0.5°). The illumination conditions at any epoch can then be obtained by comparing the Sun elevation to that of the horizon (in the Sun direction).

Results: We conduct simulations with the LOLA topography to survey the extent of PSRs in both polar regions, and to characterize the solar illumination conditions (average and maximum incident flux). We find consistently larger total PSR areas than previous studies **[2,4,5]** (e.g., 1769 and 3660km^2 polewards of 87.5° , compared to 844 and 2751km^2 for **[4]**, in the north and south poles respectively), likely because smaller PSR areas (<10km^2) are now resolved thanks to the higher LOLA altimetric data density. We also describe the influence of the Moon obliquity on the total PSR area.

Updated results will be presented, based on more recent and accurate LOLA maps constructed from improved LRO orbit knowledge **[9]** and crossover adjustment techniques **[10]**.

References: [1] Watson K.B. et al. (1961) *JGR*, *66*, 3033. [2] Margot et al. (1999) *Science*, *284*, 1658. [3] Cook et al. (2000), *JGR*, *105*, 12023. [4] Noda et al. (2008), *GRL*, *35*, L24203. [5] Bussey et al. (2010), *Icarus*, *208*, 558. [6] Mazarico et al. (2011), *Icarus*, *211*, 1066. [7] Smith et al. (2010), *GRL*, *37*, L18204. [8] Chin et al. (2007), *Sp. Sci. Rev.*, *129*, 4. [9] Mazarico et al. (2011), J. Geod., submitted. [10] Mazarico et al. (2010), Lunar Science Forum, 215.

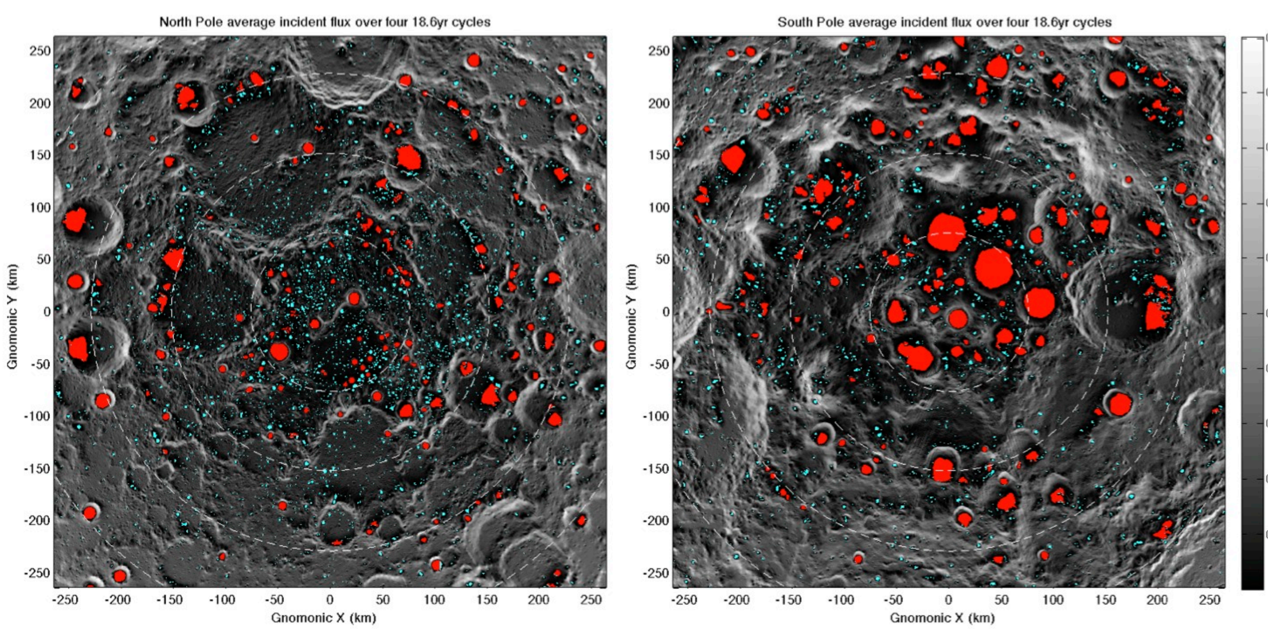

Figure 1. Permanently Shadowed Regions shown over a grayscale map of the average incident flux, for the northern (left) and southern (right) polar regions. The simulation duration was four 18.6yr cycles. For each pole, the 150 largest PSRs are in red, and the smaller ones in cyan. The dashed circles indicate latitude, in 2.5° steps from the pole. From [6].