A REVIEW OF LUNAR POLAR ILLUMINATION STUDIES USING CLEMENTINE, SMART-1, KAGUYA, & LRO DATA. D. B. J. Bussey[1], P. D. Spudis[2], [1]The Johns Hopkins University Applied Physics Laboratory, Laurel MD USA, ben.bussey@jhuapl.edu, [2]Lunar and Planetary Institute, Houston TX USA.

Introduction: The lunar poles are of great interest for both scientific and operational reasons. The discovery of permanently shadowed regions inside craters close to the poles, which are prime candidates for locations of deposits of water ice [1-6], has important ramifications for a human return to the Moon. Similarly, regions that receive near-constant solar illumination are possible sites for future lunar bases. Not only do these areas permit operations in a relatively benign thermal environment, but also a lunar base could be supported by solar photovoltaics without the need of additional power sources.

The Moon's spin axis is nearly perpendicular to the ecliptic plane, with an inclination of 1.5° from the vertical. A consequence of this is that the Sun will always appear close to the horizon near the poles, as the Moon slowly rotates on its axis every 708 hours (about 29 Earth days). Thus, topographically high and low points in the vicinity of the poles are potentially permanently illuminated or shad- owed, respectively [1-3]. Data from several missions have illuminated these relations:

Clementine: Our first comprehensive look at the Moon's polar illumination conditions came from the Clementine mission. Clementine, launched in January 1994, mapped the Moon in a near polar orbit for a period of 71 days. In doing so, it provided the first digital data set with which to analyse the lunar poles at medium-high resolution (250-500 m/pixel) with contiguous, consistent coverage. These data were collected during winter for the southern hemisphere. Using these data we produced the first quantitative illumination maps for both poles [7,8] (Fig 1).

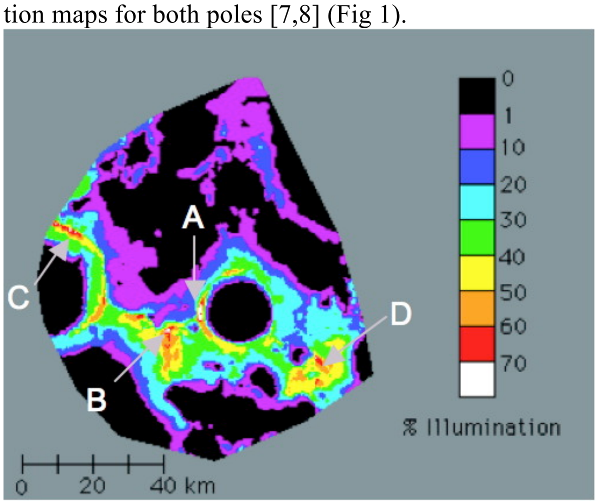

Figure 1. Quantitative south polar illumination map for a winter day, from [7].

These maps show the percentage of time that a point on the surface is illuminated during a lunar day. Key results for the south pole were: a) Identification of the locations that receive the most sunlight; b) None of these locations were permanently illuminated; c) Two locations close to the rim of Shackleton were collectively almost permanently illuminated. Key results for the north pole include indentification of places near the rim of Peary that were illuminated for an entire summer day, as well as locations of permanently shadowed craters on the floor of Peary crater.

SMART-1: The AMIE camera on SMART-1 provided additional information on the polar illumination conditions. It's main advantage over the Clementine data were that it acquired images over an entire year. Analysis of these data showed that "Point B" from the Clementine study is illuminated during an entire day in summer [9].

KAGUYA: JAXA's Kaguya spacecraft returned the first laser-derived topographic data of sufficient fidelity to be useful for illumination studies. Comparison between simulations and images with identical illumination conditions showed that the KAGUYA topography can be used to generate precise lighting predictions. We used these data to analyse the polar lighting conditions over an entire year [10]. Key results include:- 1. the areas that receive the most illumination are the same locations as we found in the Clementine and SMART-1 study, 2. Several locations are continuously illuminated for several months, centered around mid-summer, 3. Mapping out the frequency and duration of all the shadowed periods for these key locations. HDTV images of the poles from Kaguya confirm the findings from LALT and images.

LRO: The LOLA instrument on LRO is providing higher-resoltion topography of the polar regions. We have used these data to further characterize the illumination conditions in the polar regions. One aspect we are studying is the needed height of a mast to reducing the duration of shadowed periods.

References: [1] Watson et al., JGR, 1961, [2] Arnold, JGR, 1979, [3] Ingersoll et al., Icarus, 1992, [4] Shoemaker et al., Science, 1994, [5] Nozette et al., Science, 1996, [6] Feldman et al., Science, 1998, [7] Bussey et al., GRL 1999, [8] Bussey et al., Nature 2005. [9] Bussey et al., LPSC XXXIX, 2008, [10] Bussey et al., Icarus 2011, [11] Quinn et al., LPSC XXXII, 2011.