

GLOBAL CATALOGUE OF LUNAR PERMANENTLY SHADOWED REGIONS.

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Introduction: The Moon's spin axis is nearly perpendicular to the ecliptic plane. This results in the lunar polar regions experiencing unusual illumination conditions with the prevalence of permanently shadowed areas (in the floors of impact craters), and the possibility of elevated regions being near-continuously illuminated. Using an illumination-simulation tool, together with the latest topography data sets from Lunar Reconnaissance Orbiter, we have completed a map of all permanently shadowed regions on the Moon. A key result is that we have discovered permanent shadows as far from the pole as $\pm 58^\circ$ latitude. In addition to discovering that these areas exist we have begun a preliminary study of their thermal environment, using Diviner data, to determine the feasibility of non-polar volatile deposits. The overall goal is to map out all locations that could harbor volatiles.

Methodology: Our software tool, LunarShader, can precisely simulate lunar illumination conditions. Given a Sun location (either by date or exact position) and a topography file, LunarShader precisely determines which portions of the lunar surface are illuminated or shadowed. Running multiple simulations, covering time periods of several years, permits us to determine where is permanently shadowed.

Results: Early work concentrated on analysis of the Moon's polar regions [1]. We mapped which areas receive the most illumination, and then fully characterized the lighting conditions at those places. This involved determining the occurrence and location of all shadowed periods. A key result is that locations exist that receive continuous illumination for several months around mid-Summer.

The goal of the non-polar study was to identify how far from the poles can permanent shadow exist. We found that no permanently shadowed regions exist equatorial of either 58°S or 58°N . 49 areas exist in the 58° to 65° latitude range for both hemispheres. Normally the permanent shadow inside a low-latitude crater is located at the base of the poleward-facing slope of the crater, in good agreement with predictions from previous work [2,3].

Diviner data [4] have been used to explore the temperature regime of some of the low-latitude shadowed regions as well as nearby illuminated areas (for comparison). We discovered that the low-latitude permanently shadowed regions are significantly colder than neighboring illuminated regions. Further research will determine the habitability for volatiles in these areas.

References: [1] Bussey et al. 2010 *Icarus*, [2] Vasavada et al. 1999 *Icarus*, [3] Bussey, et. al. 2003 *GRL*, [4] Paige, et al. 2009 *Space Sci. Rev.*