Lyman Alpha Mapping Project (LAMP) Maps of the Lunar Poles

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Abstract

Maps of polar far ultraviolet (FUV) albedo are being produced using the Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP)'s innovative night-side observing technique. Recent updates following our original PDS release in March 2011 are reported.

1. Introduction

The LRO-LAMP is a UV spectrograph (Figure 1) that addresses how water is formed on the moon, transported through the lunar atmosphere, and deposited in permanently shaded regions (PSRs)[1,2]. LAMP far-ultraviolet (FUV) albedo maps are being produced to investigate the intriguing albedo differences that occur within PSRs.

Figure 1: LAMP instrument prior to shipment.

2. Observations

LRO's polar orbit provides repeated observations of PSRs, enabling accumulation of UV signal with the photon-counting LAMP instrument over these locations. Lyman-α albedo maps obtained over the nominal ESMD mission (Sept. 2009 to Sept. 2010) are shown in Figure 2 for the North and South poles.

The LAMP instrument (Fig. 1) covers the 57-196 nm passband. Its 6°×0.3° slit is nominally pointed nadir and scans the surface in push-broom style, similar to other LRO instruments. LAMP routinely observes the lunar nightside. When the orbit plane geometry is roughly between beta angles of ±45° the lunar dayside is also observed by switching to a pinhole mode following terminator crossings each orbit.

2.1 Data Products

LAMP high-level data products include nightside brightness maps of polar regions over specific wavelength ranges, similarly constructed albedo maps (i.e., brightness maps normalized by the varying illumination), and on-band to off-band ratio maps (i.e., maps of the ratio between albedo maps for wavelength ranges on and off important absorption bands such as water frost). The maps are created using photon lists from which individual FUV photon events are selected for inclusion based on criteria such as timing, wavelength, emission and incidence angles, and spacecraft location. The mapping products follow similar conventions to the coordinates used within LOLA instrument products.

For the albedo and ratio maps, an important intermediate product is the sky illumination as a function of wavelength and time for each surface element. On the nightside these include Lyman-α sky-glow, UV starlight, and (for near-terminator regions) scattered sunlight. On the dayside the illumination is the solar FUV flux, with crater shadowed regions removed from the compilation maps. The sky visibility, e.g., as seen from surfaces within craters, is determined using LOLA topography products, and determines the amount of incident Lyman-α sky-glow and starlight.
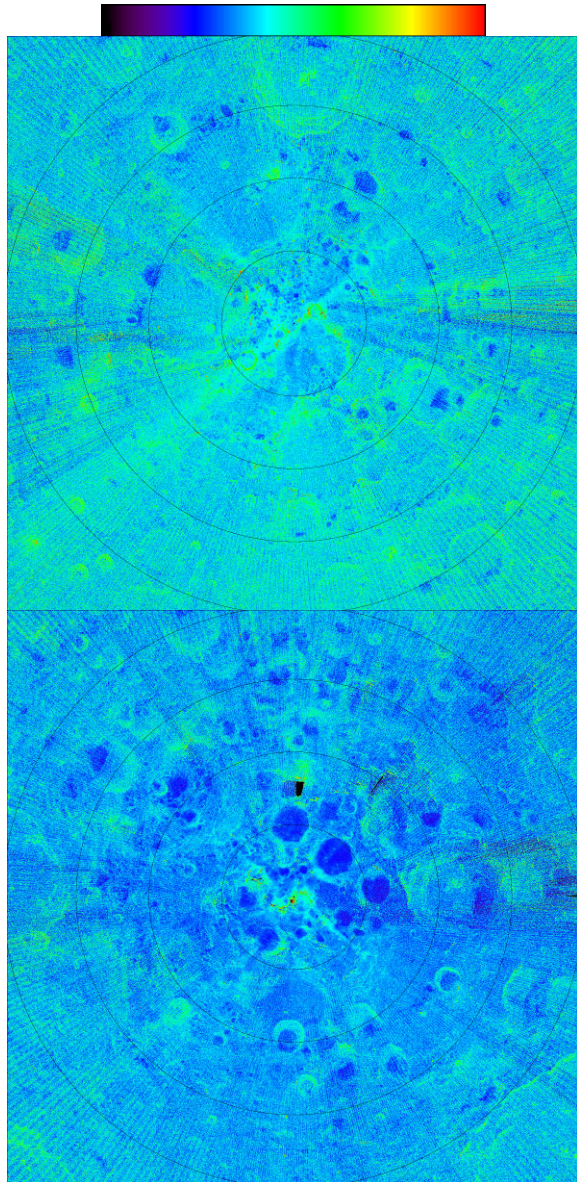
Figure 2: LAMP Lyman-α albedo maps, North (top) and South (bottom). Thin black circles indicate latitudes in 2.5° increments from the pole. Color bar runs from 0 to 10% albedo.

The LAMP high-level data products are produced monthly, and combined for best-quality compilations like the one shown in Figure 2. A few instrument-related artifacts are removed as part of our data calibration and mapping pipelines, with time-dependent microchannel plate detector gain sag and low pulse amplitude signals the primary (flat-field) issue being remedied.

3. Initial Results

The Lyman-α albedo maps shown in Figure 2 reveal lower albedo (bluer here) regions within craters. The lower albedo regions are roughly correlated with the coldest regions reported in the Diviner temperature maps. Identifying the cause of this albedo darkening at Lyman-α requires future work and spectral analysis of the full data set, but likely explanations include either the presence of UV-absorbing volatiles at the surface and/or a change in surface properties (e.g., roughness) at these interesting locations (c.f., Gladstone et al., *this meeting*).

Maps of reflected starlight at wavelengths longer than Lyman-α (121.6 nm) are also produced, but are of lower signal quality owing to the dimmer source of light at these wavelengths and the need to subtract detector background (c.f., Miles et al., *this meeting*). These longer wavelength data and related ratio maps will be presented.

4. Summary and Conclusions

The LAMP maps will be further refined to remove a few remaining artifacts. Comparisons will be made with important inputs from other LRO instruments such as surface roughness, and updated topography data. Our emphasis to date has been on production of night-side illuminated regions, although we also plan in-depth analyses of the dayside maps. Improvements to the photometric correction of the dayside maps will be pursued once bidirectional reflectance distribution function data are made available for the FUV (c.f., Retherford et al., *this meeting*).

Acknowledgements

References

[1] Gladstone, G. R., and 15 coauthors, LAMP: The Lyman Alpha Mapping Project on NASA's Lunar Reconnaissance Orbiter Mission, *Space Sci. Rev., 150*, pp. 161-181, 2010.

[2] Gladstone, G. R. et al., LRO-LAMP Observations of the LCROSS Impact Plume, *Science, 330,* pp. 472-476, 2010.