Lyman Alpha Mapping Project (LAMP) Far-Ultraviolet Maps of the Lunar Poles. K. D. Retherford[1], G. R. Gladstone[1], S. A. Stern[2], A. F. Egan[2], P. F. Miles[1], M. H. Versteeg[2], D. C. Slater[1], M. W. Davis[1], J. Wm. Parker[2], D. E. Kaufmann[2], T. K. Greathouse[1], A. J. Steffl[2], J. Mukherjee[1], D. Horvath[1], P. D.Feldman[3], D. M. Hurley[4], W. R. Pryor[5], and A. R. Hendrix[6], [1]Southwest Research Institute, 6220 Culebra Rd., San Antonio, TX 78238, [2]Southwest Research Institute, 1050 Walnut St., Boulder, CO 80302, [3]Johns Hopkins University, 3400 N. Charles St., Baltimore, MD 21218, [4]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, MD 20723, [5]Central Arizona University, [6]Jet Propulsion Laboratory, Pasadena, CA.

Introduction: The Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (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. We present here the first maps of polar FUV albedos obtained using LAMP's innovative night-side (and PSR) observing technique.

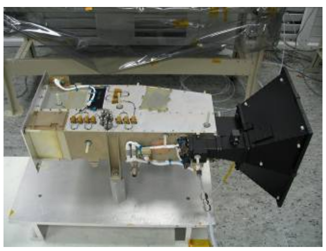

Figure 1. LAMP instrument prior to shipment.

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

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 the LOLA instrument products.

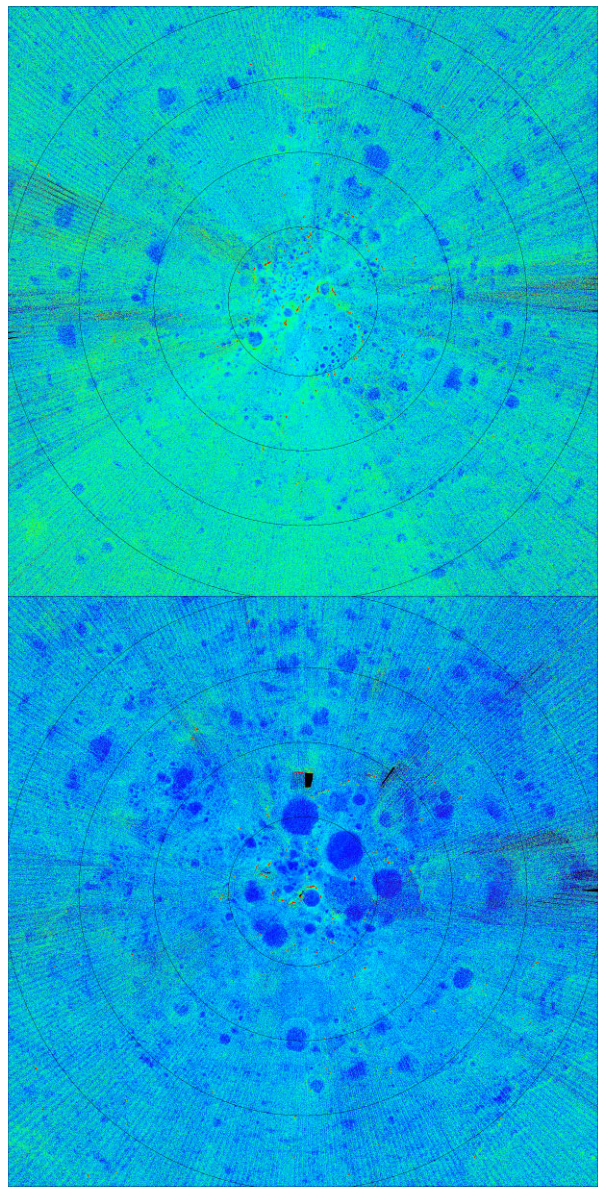

Figure 2. LAMP Lyman-α brightness maps, North (top) and South (bottom). Thin black circles indicate latitudes in 2.5° increments from the pole.

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.

The LAMP high-level data products are produced monthly, and averaged 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 the primary issue being remedied.

Initial Results: The Lyman-α brightness maps shown in Figure 2 reveal darker (bluer here) regions within craters. After division by the sky-visibility the brightness of many darker crater-related regions increase to values typical of their surroundings. However, several residual dark features remain, indicating a lower relative albedo in these regions. The lower albedo regions are roughly correlated with the coldest regions reported in the Diviner temperature maps. Identifiying 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.

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. These longer wavelength data and related ratio maps will be discussed in the presentation.

Future Work: The LAMP maps will be further refined to include 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 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.

References: [1] Gladstone, G. R., and 15 coauthors (2010) *Space Sci. Rev., 150*, 161-181. [2] Gladstone, G. R. (2010) *Science, 330,* 472-476.

Additional Information: The LAMP website is http://www.boulder.swri.edu/lamp/.