LRO Lyman Alpha Mapping Project (LAMP)'s Improved Dayside Observing Mode. K. D. Retherford[1,2], T. K. Greathouse[1], B. Byron[2,1], L. O. Magaña[2,1], M. W. Davis[1], D. E. Kaufmann[3], C. Grava[1], A. F. Egan[3], D. M. Hurley[4], J. T. S. Cahill[4], A. R. Hendrix[5], K. E. Mandt[4], Y. Liu[6], D. Wyrick[1], J. Mukherjee[1], G. R. Gladstone[1,2]; [1]Southwest Research Institute, San Antonio, TX (kretherford@swri.edu), [2] University of Texas at San Antonio, San Antonio, TX, [3]Southwest Research Institute, Boulder, CO, [4]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, [5]Planetary Sciences Institute, Tucson, AZ, [6]Lunar and Planetary Institute, Houston, TX.

Abstract. Far ultraviolet (FUV) albedo maps obtained using the Lunar Reconnaissance Orbiter (LRO) Lyman Alpha Mapping Project (LAMP)'s innovative nightside observing technique [1,2] have revealed features on the Moon in a new light. Dayside FUV maps are also obtained using the more traditional photometry technique with the Sun as the illumination source, and are very complementary. Together, these LRO-LAMP measurements provide a unique perspective on the lunar "hydrological cycle," connecting the surface abundance of water frost trapped in the Moon's cryosphere to volatile transport processes involving the lunar exosphere. Near the start of the present mission extension phase LAMP's aperture size for dayside observing was greatly expanded to increase data quality of these signals. improving searches for time variable hydration features.

LAMP Instrument and Technique. The LRO-LAMP UV imaging spectrograph is well suited to study how water is formed on the Moon, transported through the lunar exosphere, and deposited in permanently shaded regions (PSRs)[2,3]. LAMP nightside and dayside brightness maps cover wavelength range 57-196 nm. Lyman-α, on-band and off-band albedo maps (i.e., on and off the water frost absorption band at ~165 nm) are useful for constraining the abundance of surficial water frost [1,4,5].

Global dayside FUV albedo maps enable comparisons between the nightside and dayside photometry techniques to help validate the use of Lyman-α and starlight as illumination sources. Analysis of dayside spectra for selected regions complement the nightside maps, and are used to investigate space weathering and hydrated surface signatures [6]. Detailed spectral analyses of dayside measurements also support the previous identification of diurnal variations in hydration features [6].

Global nightside and dayside maps are divided (at ±60° latitude) into polar and equatorial regions with stereographic and equirectangular projections, respectively. Additionally, spectral image cube maps have been created for several regions of interest with 2 nm resolution, and are being expanded to cover the full globe.

New Dayside Investigations. LAMP has implemented an exciting new operating mode that enhances the sensitivity of dayside observations by 1-2 orders of magnitude. A one-time opening failsafe door had been included in the design of the LAMP instrument, in case the main aperture door mechanism had somehow failed (stuck shut for example). By opening this failsafe door device a previously blocked component of the telescope's 4 cm by 4 cm aperture would be viewable to space in any event, allowing a 10% throughput of signal compared to the full aperture size [7]. The door itself had been designed with a pinhole aperture for dayside observations at count rates comparable to the nightside signals with a 0.14% throughput. The effective area of dayside observations improved by a factor of 73.6 as a result of this change, allowing better data quality measurements.

This failsafe door was opened on the night of October 4, 2016. A new calibration of the instrument in both observing modes is implemented from this date forward. LAMP's raw data products now include a slant in the spectral line profiles for dayside observations, with wavelengths to be calibrated individually by rows to correct for this slant. The flat-field and effective area values are also revised in the extended mission dataset. A known gain-sag effect, dependent on accumulated fluence, adds another layer of complexity to the complication for the responsivity of signals at the Lyman-α wavelength of 121.6 nm, which requires an additional correction that is in progress.

Global searches of water signatures outside of PSRs with these newly improved LAMP dayside data are allowing us to confirm and elucidate the findings of surface water/hydroxyl and its variability. The data quality is on par with the initial detections of such surficial water signatures within infrared Chandryaan-M3/Cassini-VIMS/EPOXI data for example [8,9,10], enabling more robust searches for diurnal variations. The present LRO extended science mission enables more surface reflectance data (60-190 nm) at a variety of incidence and emission angles to improve signal, spectral, and photometric quality and further develop our innovative UV reflectance techniques.

References [1] Gladstone, G. R. et al., Far-Ultraviolet Reflectance Properties of the Moon's Permanently Shadowed Regions, *J. Geophys. Res.*, *117*, E00H04, 2012. [2] Gladstone, G. R., et al., LAMP: The Lyman Alpha Mapping Project on NASA's Lunar Reconnaissance Orbiter Mission, *Space Sci. Rev.*, *150*, 161-181, 2010. [3] Gladstone, G. R. et al., LRO-LAMP Observations of the LCROSS Impact Plume, *Science, 330*, 472-476, 2010. [4] Retherford, K. D., et al., LRO/LAMP Far-UV Albedo Maps, *in preparation*, 2018. [5] Hayne, P. O. et al., Evidence for Exposed

Water Ice in the Moon's South Polar Regions from Lunar Reconnaissance Orbiter Ultraviolet Albedo and Temperature Measurements, Icarus (volume 255, pages 58-69, doi:10.1016/j.icarus.2015.03.032). [6] Hendrix, A. R., et al., Lunar Albedo in the Far-UV: Indicator of Hydrated Materials and Space Weathering, *J. Geophys. Res.*, 117, E12001, 2012. [7] Davis, M. W., et al., LRO-LAMP failsafe door-open performance: improving FUV measurements of dayside lunar hydration, SPIE, 2017. [8] Pieters C. M., et al., Character and Spatial Distribution of OH/H_2O on the Surface of the Moon Seen by M^3 on Chandrayaan-1, Science, 326(5952), 568-572, 2009. [9] Sunshine J. M. et al., Temporal and Spatial Variability of Lunar Hydration as Observed by the Deep Impact Spacecraft, Science, 326, 565, 2009. [10] Clark R. N., Detection of Adsorbed Water and Hydroxyl on the Moon, Science, 326, 562, 2009.