DIURNAL VARIATION OF LUNAR ALBEDO PROTON YIELD AND HYDROGENATION. J. K. Wilson[1], N. A. Schwadron[1], A. P. Jordan[1], M. D. Looper[2], C. Zeitlin[3], L. W. Townsend[4], H. E. Spence[1], J. Legere[1], P. Bloser[1], W. Farrell[5], D. Hurley[6], N. Petro[5], T. J. Stubbs[5], C. Pieters[7], [1]University of New Hampshire, Space Science Center and Inst. of Earth, Oceans and Space, Morse Hall, 8 College Rd, Durham, NH 03824, USA (jody.wilson@unh.edu), [2]The Aerospace Corporation, El Segundo, CA 90245-4609, USA, [3]Leidos, Houston, Texas 77042, USA, [4]University of Tennessee, Knoxville, TN, 37996, [5]Goddard Spaceflight Center, 8800 Greenbelt Rd, Greenbelt, MD 20771, [6]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, [7]Brown University, Planetary Geosciences Group, Dept of Earth Environmental and Planetary Sciences, 324 Brook St, Providence, Rhode Island, 02912.

Summary: The CRaTER instrument on LRO has detected a diurnal variation in the yield of ~100 MeV albedo protons being emitted from the lunar surface. We use a new type of horizon-viewing observation, and find that the proton yield is higher over the dawn terminator than the dusk terminator. The simplest physical explanation is that mobile hydrogen or hydrogen-bearing molecules are more concentrated at the pre-dawn lunar surface; forward-scattering knock-on collisions of grazing-incidence galactic cosmic rays (GCRs) and albedo neutrons with protons (hydrogen nuclei) in the lunar regolith will increase the yield of protons relative to the GCR source, qualitatively consistent with our observations.

New Observing Mode: CRaTER is normally oriented vertically, with one end of the telescope facing the Moon and the other end pointed at the zenith. During periods when the polar orbit of LRO was over the lunar terminator, LRO was rotated to point the edge of CRaTER's field of view to within 1° of the lunar horizon, allowing for direct detection of albedo protons leaving the surface at nearly horizontal angles. (See Figure 1.) We have been collecting 10s of hours of such observations every year starting in 2015.

Data reduction: To accurately calculate the yield of lunar albedo protons at different local times, we carefully subtract the background signal in the instrument, as well as account for systematic variations in the actual or measured GCR flux. We use all six detectors in CRaTER to distinguish albedo protons from GCR protons, and then fit an exponential function to the background LET spectrum in one detector to isolate and count the protons. We also detect and account for a small difference in the dawn vs. dusk flux of incident GCRs due to streaming along interplanetary magnetic field lines. (details in Schwadron et al. 2017[1])

Implications: The size of the dawn yield enhancement suggests that a significant population of hydrogen or hydrogen-bearing molecules are mobile over or within the surface of the Moon. Schwadron et al.[2] found a 1% high-latitude enhancement in the nadir-viewing proton yield using CRaTER, and concluded that the small signal required ~1% H by mass (~10% H_2O equivalent) at depths of 10-20 cm in the regolith, which is on the high side of the range found by other studies. The dawn grazing-angle enhancement seen here suggests a portion of the global H population is concentrated towards the dawn sector of the Moon; this is reminiscent of Schorghofer's [3] model of mobile lunar H2O which predicts a dawn H2O regolith concentration that is orders of magnitude larger than that just prior to sunset.

References: [1] Schwadron N., et al. (2017), in review, [2] Schwadron, N., et al. (2016), Icarus, 273, 25-35, [3] Schorghofer, N. (2014), GRL, 41, 4888-4893.

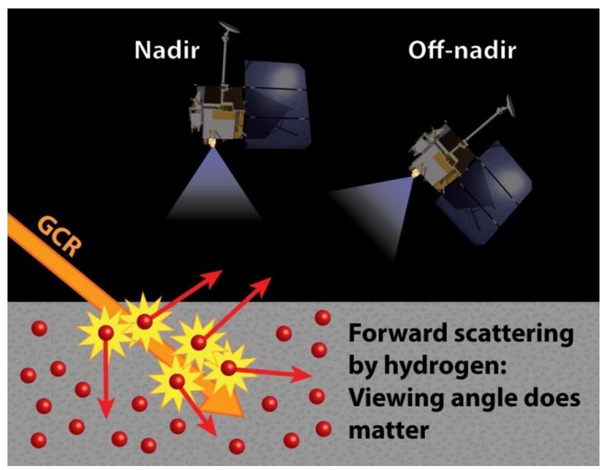

Figure 1. The orientation of CRaTER's fieid of view relative to the lunar horizon affects CRaTER's sensitivity to the products of forward-scattering (knock-on) collisions of GCRs with