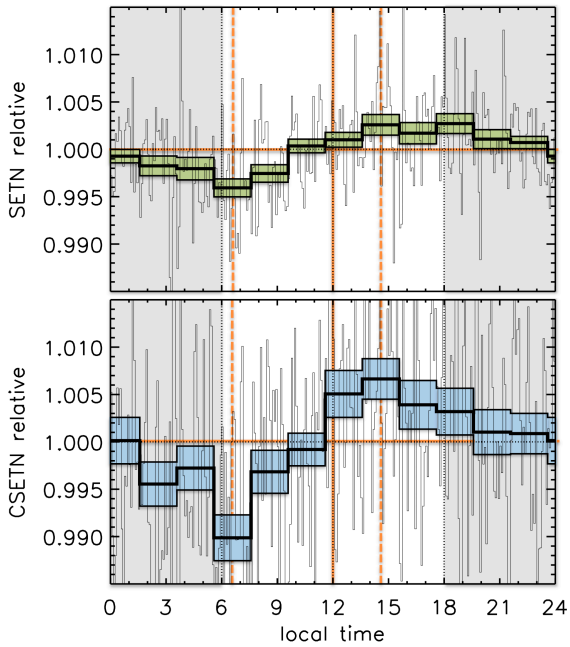
EVIDENCE FOR DIURNALLY VARYING HYDRATION AT THE MOON'S EQUATOR FROM THE LUNAR EXPLORATION NEUTRON DETECTOR (LEND). T. A. Livengood[1], G. Chin[2], R. Z. Sagdeev[3], I. G. Mitrofanov[4], W. V. Boynton[5], L. G. Evans[6], M. L. Litvak[4], T. P. McClanahan[2], A. B. Sanin[4], R. D. Starr[7], [1]Department of Astronomy, University of Maryland, College Park, MD 20742, tlivengo@umd.edu, [2]NASA Goddard Space Flight Center, Greenbelt, MD, [3]Department of Physics, University of Maryland, College Park, [4]Institute for Space Research, Moscow, Russia, [5]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, [6]Computer Science Corporation, Lanham-Seabrook, MD, [7]Physics Department, Catholic University of America, Washington, DC.

We detect hydrogen-bearing volatiles, most likely water and hydroxyl, concentrated near the Moon's dawn terminator by an active daily cycle of surface hydration and dehydration. This represents a potential volatile resource for *in situ* resource utilization (ISRU) that is distilled by natural processes and thus may be accessible at minimal energy cost. Measurements by the Lunar Exploration Neutron Detector (LEND) on the polar-orbiting Lunar Reconnaissance Orbiter (LRO) spacecraft detect hydrogen in the regolith through the localized suppression of epithermal neutron flux from the Moon's surface. At low latitude, the greatest flux suppression is found at dawn, with the least suppression and least hydrogenation in the lunar afternoon. This non-uniform and asymmetric distribution can persist only if a population of hydrogen-bearing volatiles is mobile across the sunlit lunar surface in the morning sector with an average horizontal velocity of 4.3 m/s in the anti-sunward direction, enabling the detected hydrogen to remain fixed with respect to the Sun while the Moon rotates.



Equatorial neutron detection rate varies as a function of local time for the LEND uncollimated detector SETN (*upper panel*) and the collimated detector CSETN (*lower panel*) epithermal neutron detectors, measured relative to the zonal median detection rate. Gray regions at the left and right show lunar night. The light-toned rapidly-varying histogram shows flux measured in intervals of 5 minutes of lunar local time. The bold histogram and shaded envelope show mean and standard error of the mean in two-hour intervals. The greatest flux suppression is found on the day side of the dawn terminator.

The source of the diurnally-varying water is not known and could be either indigenous or exogenous. The solar wind may implant hydrogen in the lunar surface, where it can react with oxygen from regolith materials to yield hydroxyl or water [1]. The estimated equatorial average water concentration could accumulate from the solar wind in approximately a million years if ~4% of impacting H atoms survive in water molecules [2]. Impacts by cometary bodies or cometary dust also may deliver material, accounting for carbon oxides observed in the LCROSS impact plume [3]. Direct impacts by comets would deliver volatiles episodically, whereas cometary dust may be delivered more or less continually by meteors.

Surface reservoirs of water and carbon oxides near the equator may be of significant value for *in situ* resource utilization (ISRU) for astronaut life support and to make fuel and oxidizer. ISRU with polar deposits would require machinery to mine cold regolith, possibly from within PSRs, heating a large mass of regolith to smelt a modest mass of volatiles. At low latitude, sunlight naturally distills volatiles from the regolith. A cold surface exposed to the tenuous atmosphere could be used to capture volatiles as frost, scraping the material off for use.

References: [1] Ichimura, A. S., *et al.* (2012). *E&PS Let* **345–348**, 90–94. [2] Crider, D. H. and Vondrak, R. R. (2000). *JGR-Planets* **105**, 26773–26782. [3] Hurley, D. M. *et al.* (2012). *JGR-Planets* **117**, E00H07.