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Updated Mapping of Hydrogen in the Lunar Southern Polar Regions according to LEND/LRO data

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Determining the amount of water ice in the lunar regolith is an important task not only from a scientific point of view, but it is also important for exploration, since water may be used in many aspects - from the production of rocket fuel to direct use by astronauts during their stay on a habitable lunar base. One of the methods of remote sensing for hydrogen-bearing compounds, such as water ice, in the upper 1–2 m subsurface soil layer of atmosphereless celestial bodies is the spectroscopy of the neutron leakage flux from the surface. To estimate water equivalent hydrogen (WEH) in the lunar soil we have used data of Lunar Exploration Neutron Detector (LEND) aboard the Lunar Reconnaissance Orbiter (LRO), operating almost continuously in orbit around the Moon from 2009 to the present [1].

LEND is the collimated epithermal neutron telescope which uses the passive neutron collimator to collect most of neutron signal at a narrow field of view (FOV). Dataset gathered by LEND till April 1, 2015 was early used to estimate the water equivalent hydrogen (WEH) and create maps of its distribution [2]. After 5 years of additional data accumulation we update the WEH map in the Southern circumpolar region, including both large permanently shadow regions (PSRs) and neutron suppression regions (NSRs), which might be partially overlapping with PSRs and often extends on sunlit areas.

The updated map is done not only by the new larger dataset, but by new WEH estimation method also. This method uses precise estimation of the neutron flux at different altitudes of spacecraft orbits modelled with specially developed code based on the Geant4 toolkit with additional treatment of the neutron propagation in the lunar gravity field. Also, the method precisely accounts the fact of the collimator partial transparency, which leads to additional background counting rate in detectors dependent on WEH in the soil at surrounding regions located out of the instrument FOV.

References:

1. Mitrofanov I. et al. (2010) Space Sci. Rev., 150, 183–207.
2. Sanin A. B. et al. (2017) Icarus, 283, 20-30.