**On the effect of Magnetospheric Shielding on the Lunar Hydrogen Cycle.** O.J. Tucker, W.M. Farrell and A.R. Poppe.  

**Introduction:** The hydrogen cycle on the Moon is a potential resource for future lunar exploration. When the Moon traverses Earth’s magnetosphere the mean ion flux is $2.4 \times 10^8$ cm$^{-2}$s$^{-1}$ in the magnetosheath and $0.22 \times 10^8$ cm$^{-2}$s$^{-1}$ in the magnetotail, compared to the solar wind (SW) value of $1.9 \times 10^8$ cm$^{-2}$s$^{-1}$ [1]. The lunar hydrogen content is expected to be depleted during full Moon because $H_2$ has a short lifetime for escape, ~72 minutes. This decrease in hydrogen should be observable in the 3-micron feature on the surface on the near side of the Moon [2,3] and in observations of the $H_2$ exosphere [4,5]. The Monte Carlo approach described in Tucker et al., [2019] [6] is used to estimate surface hydroxylation and the $H_2$ exosphere during full Moon.

![Figure 1: Moon orientation during ARTEMIS measurements from of sheath (solid curve) and magnetotail (dotted curve) [1].](Image)

**Methodology:** Tucker et al., [2019] showed that hindered diffusion of implanted hydrogen caused by physical and chemical trapping is consistent with the observed global OH surface concentrations [2] and $H_2$ exosphere [4]. In this approach, a myriad of defects leads to the formation of hydroxyls during the H to $H_2$ diffuse pathway is modeled using a distribution of activation energies [7].

Unfortunately, current observations cannot distinguish between surficial OH/$H_2O_2$, and observations of the $H_2$ exosphere are limited [4,5]. Therefore, the role of H to $H_2$ as a dominant pathway in the hydrogen cycle remains under examination [2,7,8,9,10]. To this end, we use the approach in Tucker et al., [2019] to predict the hydrogen content during full Moon for future model-observation comparisons. Three simulations will be presented: 1) SW source turned off in the tail, 2) ion source rates in the sheath and tail taken from ARTEMIS [1], and 3) ARTEMIS flux and energy spectra used to investigate the effect of implantation depth on degassing.

**Results:** Figure 2 shows results from a simulation using a proton flux for the tail 2 orders of magnitude smaller than typical SW showing the relative decrease of OH and $H_2$ during full Moon. We will present results of the simulation cases. $H_2$ is loss over a short timescale compared to time spent in the tail. Observations during full Moon can provide useful constraints for models of the hydrogen cycle.

![Figure 2: Model results of surface concentration(left) and exospheric $H_2$(right) during new and full Moon.](Image)

[1] Poppe et al., [2018] JGR, Planets, 123.
[2] Li and Milliken, [2017] Science Advances, 3.
[3] Cho et al., [2018] JGR Planets, 123.
[4] Stern et al., [2013] Icarus, 226.
[5] Thampi et al., [2015] PSS, 106.
[6] Tucker et al., [2019] JGR, Planets, 124.
[7] Farrell et al., [2017], Icarus, 255.
[8] Bandfield et al., [2018] Nature Geoscience, 11.
[9] Jones et al., [2018] GRL, 45.
[10] Wohler et al., [2017] Sci Adv., 3.