On the effect of Magnetospheric Shielding on the Lunar Hydrogen Cycle. O.J. Tucker¹, W.M. Farrell¹ and A.R. Poppe². ¹NASA/GSFC, Greenbelt, MD, USA, ²University of California, Berkeley, CA, USA, (orenthal.j.tucker@nasa.gov).

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 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 \(OH/H_2O\), 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)