ANALYSIS OF LADEE MEASUREMENTS OF H₂ IN THE LUNAR EXOSPHERE. Khari M. Fletcher¹, Orenthal J. Tucker², NASA Goddard Space Flight Center ¹khari.fletcher@bison.howard.edu ²orenthal.j.tucker@nasa.gov

Introduction: The Lunar Atmosphere and Dust Environment Explorer (LADEE) hosted a state-of-the-art Neutral Mass Spectrometer (NMS) that was used to analyze the variations of molecular species due to the time day about the equator of the moon. The NMS provided data that expressed the amount at which a specific mass was prevalent during the measurements (counts/second). To date only helium, neon, argon and water have been analyzed in detail (e.g., Benna et al., 2015; 2019).

Here, we report on our efforts to carry out the first analyses of NMS data of molecular hydrogen. H₂ is produced in the lunar environment by solar wind implantation (Tucker et al., 2021) and impact vaporization from meteorite bombardment (Hurley et al., 2016). These findings will be used to analyze the variation of H₂ in the exosphere as a function of the lunar phase to gain a higher understanding of how exogenous sources interact with the moon to produce water products.

Previous Observations of H₂: To date, there have been sparse publications on the observations of H₂ in the lunar exosphere. The Lyman Alpha Mapping Project (LAMP) on the Lunar Reconnaissance Orbiter reported on orbit averaged measurements of H₂ of 1,000 ± 500 and 1,400 ± 500 cm⁻³ at the morning and evening terminators, respectively (Cook et al., 2013). The Chandrayaan-I Altitudinal Composition Explorer (CHACE) reported a H₂ density of 500 – 800 cm⁻³ on the lunar dayside during the full Moon phase (Thampi et al., 2015). These measurements lend credence to the idea of solar wind protons being a significant source of H₂ into the exosphere, which is still under investigation (e.g., Starukhina, 2006 Crandall et al., 2019; Tucker et al. 2019; Jones et al. 2018).

Methodology: The LADEE mission (launched 2013) is the most recent lunar exploration that orbited the moon to gather information about the structure and composition of the lunar atmosphere (Mahaffy et al., 2014). LADEE operated for approximately 7 months obtaining information about the day vs. night differences, altitude variations and variations while in the magnetotail. The NMS instrument measured gaseous samples using two methods: open source and closed source. Closed ion source sampling is typically used, especially for species that are not highly reactive with the chamber walls like H₂. This project reviews all closed ion source raw data for mass channels that sampled the mass 2 Da peak from the LADEE mission via the NASA Planetary Data System (PDS).¹ A custom program has been developed in Python and Fortran to convert LADEE counts/sec of mass channels 2.0 Da into units of number density. The mass peak can shift slightly ~0.2 Da due to thermal effects during operations (Mahaffy et al., 2014). The PDS data for this mass range are compiled into a new datasheet organized by time and mass.

In this presentation, we will discuss updates on the conversion of LADEE H₂ counts/sec to number density. We will compare the variations in the measurements with solar flux and the lunar phase. Future work will include comparisons to Monte Carlo models of solar wind (Tucker et al., 2021) and impact vaporization (Hurley et al., 2016). Such model-data studies would allow the partitioning of both the source and respective inventories of water products to obtain greater insight on the lunar water cycle.

Acknowledgements: This work is supported by the NASA/ISFM FLaRE and EIMM packages at GSFC.

References:

¹http://atmos.nmsu.edu:8080/data_searches/NMS_Browser