THE LUNAR SODIUM EXOSPHERE FROM GROUND BASED OBSERVATIONS. T. H. Morgan[1], A. E. Potter[2], R. M. Killen[1], R. Tucker[3], J. D. Johnson[4], [1]NASA/Goddard Space Flight Center, Greenbelt, MD, [2]National Solar Observatory, emeritus, [3]Imaging Technology Lab, University of Arizona, Tucson, AZ; [4]Howard University, Washington DC (thomas.h.morgan@nasa.gov).

Introduction: In order to observe the lunar sodium exosphere out to one-half degree around the Moon, we designed, built and installed a small robotically controlled coronagraph at the Winer Observatory in Sonoita, Arizona. Observations are obtained remotely every available clear night from our home base at Goddard Space Flight Center or from Prescott, Arizona. Our data encompass lunations in 2015, 2016, and 2017, thus we have a long baseline of sodium exospheric calibrated images. During the course of three years we have refined the observational sequence in many respects. Therefore this paper only presents the results of the spring, 2017, observing season. We present limb profiles from the south pole to the north pole for many lunar phases.

Discussion and Conclusions: The surface number densities that we have inferred, on the order of < 1 cm^{-3}, are much less than those reported by Potter and Morgan (1988), which were on the order of 30 cm^{-3} for phase angles >50°. Our scale heights are correspondingly larger, on the order of 1000 km compared with 320 - 388 km for comparable phase angles reported by Potter et al. (1988) [1]. The Potter and Morgan (1988) observations were obtained at altitudes between 100 and 400 km above the lunar surface. Our observations were obtained from approximately 143 km off the lunar surface to about 1 lunar radius above the surface, 1738 km. The lower exosphere, which has been reported to decrease as cos^2 from the subsolar point along the equator, has a characteristic temperature of about 1500 K, consistent with a photon-stimulated desorption source. However, Potter and Morgan (1994) [2] showed a large variation in Na intensity from a cosine function, consistent with our results. Because the sodium at the limb is very small or nil within 25° of full moon, those results are not shown. Nevertheless they are an important observation and are consistent with the Potter and Morgan, 1994, results. The more extended source that we observe has a characteristic temperature of about 4500 K, consistent with impact vaporization. Comparison of these results may imply that the lunar Na exosphere has a two component source. We see an interesting correlation between our observations and surface composition measurements taken by the Chandrayaan-1 X-ray spectrometer (CIXS) which derived Na abundances of Na 2-3 wt% at mid-southern latitudes [3], where we observed enhancements in the lunar Na exosphere. Another interesting correlation is between an enhancement in the mid-latitude Na exosphere May 1 & 2, 2017 (Phase 117 & 118, waxing), and an observed impact flash reported online as *Detected NEO Lunar Impact Event ID 20170501_203101*. The increase in abundance on March 8, 2017 (Phase 56, waxing) could be associated with the Pi Virginid meteor shower. The results of Cremonese and Verani (1997) [4] also emphasize the importance of meteoritic impacts in the production of the lunar sodium exosphere. We have not found any correlation with solar wind activity in these observations.

References: [1] A. E. Potter and T. H. Morgan, 1988, JGR 103; [2] A.E. Potter and T.H. Morgan, 1994, GRL 21; [3] P. S. Athiray et al., 2014. Planet. Space Sci. 104; ,[4] G. Cremonese and S. Verani, 1997. Adv. Space Res. 19.

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