# OPTICAL MONITORING OF THE DUST ENVIRONMENT AROUND LUNAR EXPLORATION SITES.

R. Lolachi[1, 2,*], D. A. Glenar[1, 2], T. J. Stubbs[2]. [1]University of Maryland, Baltimore Co., Baltimore, MD, [2]NASA Goddard Space Flight Center, Greenbelt, MD. *Corresponding author: rlolachi@umbc.edu

**Abstract:** The lunar dust environment and its impact on surface operations during the Artemis era are critical areas of study at this time. Lessons from the Apollo program showed that dust perturbed by human activities on the lunar surface can interfere with the operation of mechanical, thermal and optical systems, in particular the integrity of moving mechanisms and pressure seals[1].

Monitoring the local dust environment during surface activities by measuring the overlying dust loading will be an important capability. This could be accomplished at individual locations using elevated in situ dust detectors; however, a complementary, and arguably more comprehensive, approach would be to measure the intensity of scattered sunlight from dust in the environment surrounding an exploration site.

These measurements can be accomplished using modest cameras and will yield the abundance of dust along an observer line-of-sight. Observations along several look-directions can reveal the dust spatial distribution and can also constrain the average grain size by measuring the angular width of the forward scattering lobe. Perhaps most importantly, these measurements will be able to constrain spatial and temporal variations in dust ejection and deposition rates. Optical measurements of this type can be very sensitive, as demonstrated by the recent detection of faint FUV sunlight scattering by dust in the permanent impact-generated ejecta cloud surrounding the Moon[2].

Using a precomputed grid of scattering properties for realistically-shaped grains, we simulate spectral intensities for the scattering of sunlight by a plausible steady-state dust distribution (Fig. 1) around an exploration site to assess the feasibility of using commonly available wide-angle optics and commercial off-the-shelf (COTS) image sensors to create a simple notional dust monitoring camera. We model the dust detection sensitivity of cameras constructed using the PL1 (LEIA) imager aboard LICIACube (companion CubeSat on the NASA DART mission)[3], as well as sensors available from Hamamatsu and Ximea. Our present dust scattering grid spans UV to near-IR wavelengths and is computed for multiple grain shapes and sizes. Our results indicate that a simple camera can successfully detect a steady-state anthropogenically-raised dust cloud with a peak concentration of < 1 μg $m^{-3}$ for a polar site on the Moon—well below what might be expected during surface activities on Artemis missions. Additionally, zodiacal light can be monitored and used as a periodic calibration source[4].

**References:** [1] Gaier, J.R. (2005), NASA/TM—2005-213610. [2] Glenar, D.A., et al. (2019), Fall AGU meeting, #P21B-06. [3] Cheng A.F. et al. (2020) *Icarus*, 352, 113989. [4] Glenar, D. A. et al. (2014), *JGR Planets*, 119, 2548–2567.

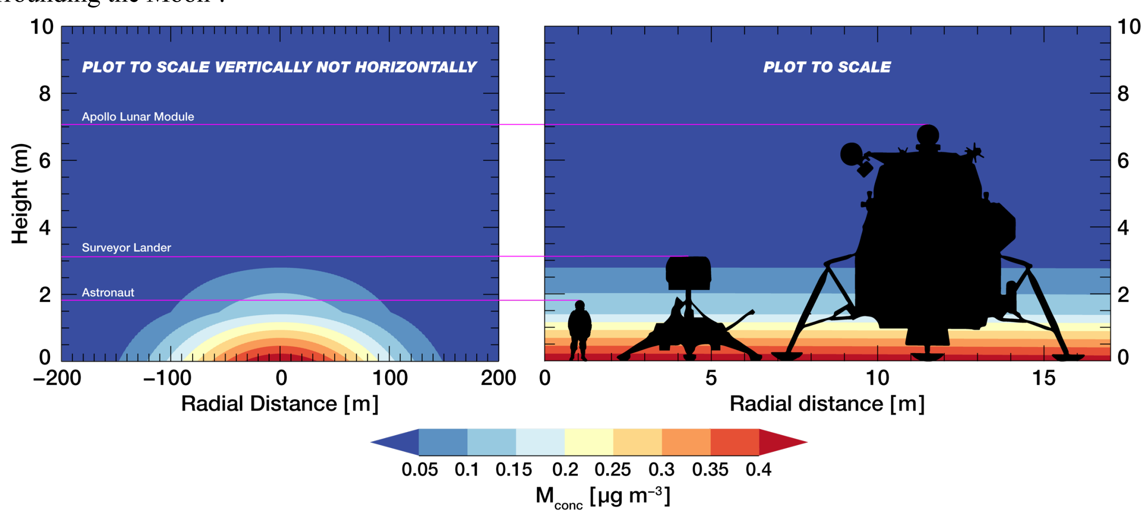


**Figure 1 |** *(Left)* Cross-section of the dust mass concentration model across the exploration site used in this study *(Right)* Astronaut, Surveyor spacecraft and Apollo Lander given for size comparison to vertical scale of model. The large difference between the vertical and horizontal scaling of the model means that an astronaut or spacecraft would experience an almost plane-parallel change in dust abundances. Our results indicate that during Artemis missions a COTS-based camera could even detect highly tenuous dust clouds produced by surface operations with peak mass abundances of <1 μg $m^{-3}$ for a polar site on the Moon.