Characterizing Lunar Dust Impact Plumes. E. Bernardoni[1,2], M. Horanyi[1,2], and J. Szalay[3], [1]Laboratory of Atmospheric and Space Physics, Boulder, Colorado, USA, [2]Department of Physics, University of Colorado Boulder, Boulder, Colorado, USA, [3]Department of Astrophysical Sciences, Princeton University, New Jersey, USA.

Introduction: The Lunar Dust Experiment (LDEX) on-board the Lunar Atmosphere and Dust Environment Explorer (LADEE) mission observed from 9/2014 to 4/2015 a dynamic and permanently present dust cloud around the Moon produced by continual meteoroid bombardment. Through the implementation of a forward modeling approach using a two-dimensional single plume ejecta model, Szalay and Horanyi revealed that this dust environment is sensitive to meteoroid showers [1,2,3].

The sporadic background contribution to the impacting dust flux is dominated by helion (HE), apex (AP), and antihelion (AH) sources oscillating with lunar phase (See Figure 1). An estimate for the flux ratio of HE to AH sources was derived as well as the initial mass, speed, and angle from surface normal distributions of the ejecta. The speed distribution, however, was recently improved to account for the correlation between local time and altitude of the sampling [2]. By implementing these improved distributions into a three-dimensional self-consistent multiple ejecta plume model fitted to LDEX data, we will provide a correction to the angular distribution fit as well as an estimate of the average total meteoroid flux at 1 AU for the three main impactor sources.

Model Corrections: In addition to implementing the new ejecta speed distribution, this project introduces another parameter to chi-squared minimization fit. The new parameter relates to the perpendicular offset of the spacecrafts trajectory to the center of the ejecta plume. In the two-dimensional model fit performed by Szalay and Horanyi, the spacecraft was assumed to have flown through the center of each ejecta plume. Under this assumption, several plume fits produce unusually narrow ejecta angular distributions [1,2,4]. As these narrow angular distributions fits may be due to the spacecraft trajectory clipping the edge of the dust plume, an offset parameter is introduced to remove the previous assumption.

With a full three-dimensional model of lunar impact eject plumes fitted to LDEX data, an estimate of the meteoroid flux at 1 AU source is then attempted. Under similar assumptions to those used in the two-dimensional fit, the impactor flux only contributes to the ejecta yield of each plume, not the ejecta distributions [3,4]. In addition, each of the three main impactor sources (HE, AP, and AH) have characteristic impact angles relative to the ram direction of the moon (See Figure 1). Thus the relative contribution of each source to a point in the spacecrafts trajectory can be simulated through random sampling of the three-dimensional plume model (corrected for the moons crossection). To perform this fit, the values of average impactor mass and speed must be fixed or sampled from a known distribution. These values are set based on models from previous literature.

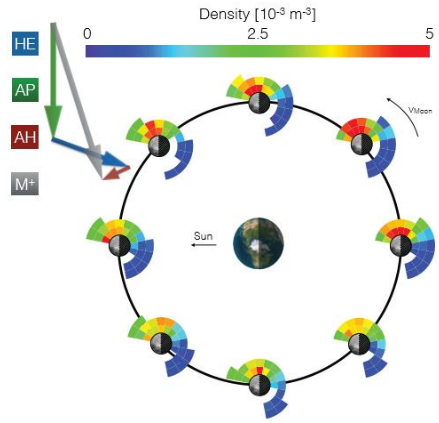

Figure 1. Lunar dust distribution as a function of lunar phase, averaged from 1/2014 to 4/2014. Characteristic impactor angles per source are shown [4].

Conclusion: The correction to the eject velocity distribution and the inclusion of an addition offset parameter provide an improved model for lunar impact ejecta plumes observed by LDEX. This new fit reduces the number of outlying fits, and shows that the distrubtions are independent of altitude and impact location. Using these improved ejecta distrubtions and a three-dimensional multi-plume model, estimates of impactor flux (and thus the meteoroid flux at 1 AU) by source are explored.

References:

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