LUNAR CRATER OBSERVATION AND SENSING SATELLITE (LCROSS) MISSION: OPPORTUNITIES FOR OBSERVATIONS OF THE IMPACT PLUMES FROM GROUND-BASED AND SPACE-BASED TELESCOPES. J.L. Heldmann[1], T. Colaprete[1], D. Wooden[1], E. Asphaug[2], P. Schultz[3], C.S. Plesko[2], L. Ong[2], D. Korycansky[2], K. Galal[1], and G. Briggs[1], [1]NASA Ames Research Center, Moffett Field, CA, 94035, [2]University of California at Santa Cruz, Santa Cruz, CA, 95064, [3]Brown University, Providence, RI, 02912

Introduction: The primary objective of the LCROSS (Lunar Crater Observation and Sensing Satellite) mission is to help advance the Vision for Space Exploration by investigating the presence of water on the Moon. The LCROSS mission, which is a comanifested payload launching with the Lunar Reconnaissance Orbiter in October 2008, will use the Atlas V Centaur Earth departure upper stage (EDUS) of the launch vehicle as a 2000 kg kinetic impactor. The impact creates an ejecta plume whose properties, including water ice and vapor content, will be observed a shepherding spacecraft (S-S/C) plus Earth- and space-based telescopes. Following a similar trajectory of the EDUS, the S-S/C will fly through the EDUS impact plume and then the 700 kg S-S/C will also impact the Moon. The S-S/C impact will likely also be observable to ground-based and space-based telescopes.

Impact Characterization: The LCROSS mission uses the impact of the EDUS to excavate and eject lunar surface material from a permanently shadowed region into sunlight where the ejecta can be imaged and spectroscopically studied at visible through mid-IR wavelengths by the LCROSS S-S/C and from the UV (HST) through radio (ODIN). Modeling the impact facilitates effective planning and execution of the observational campaign.

Models for the LCROSS impact are based on numerical hydrodyanamic codes, impact experiments with the NASA Ames vertical gun, and analytical models using semi-empirical scaling relations derived from laboratory experiments. All approaches contribute information to the task of guiding the design of the LCROSS mission and observational campaign. Such a variety of approaches and the corresponding ranges of results will very likely prove more useful in bracketing the expected outcomes.

To aid in the formulation of the LCROSS mission and measurement design, a compilation of model results has been built which summarizes the current best estimate for the impact event. This summary, called the Current Best Estimate Impact Model (CBEIM), includes both high and low values for a variety of relevant physical quantities including crater dimensions and ejecta velocities (see Figures 1 and 2). In most cases the “current best estimate” was used for design purposes, however, on a case-by-case bases additional “margin” was allowed for by using the model results between the best estimate and the modeled low estimate (e.g., often the values closer to the low-end expectation for the total ejected mass above 2 km were used in order to build in margin). To date, models for the impact indicate that the impact flash will evolve in tens of milliseconds and the impact ejecta will rise into sunlight and fall back to the lunar surface in less than about 2 minutes, thereby motivating the use of rapid measurement techniques for ground- and space-based telescopes. Only the temporal evolution of the OH^- exosphere is expected to persist for more than tens of minutes.

Observational Support: Ground-based and orbital observatories can observe the dust and water vapor plume caused by the two impacts into the lunar surface. Compared to the Deep Impact (DI) Mission encounter with comet 9P/Tempel, LCROSS’s EDUS impact plume will have 100 times less mass at 360 times closer range, so the surface brightness will be higher. However, the dust-to-ice ratio for the impact location regolith is expected to be orders of magnitude greater, perhaps ~100 in comparison to ~0.5 for Deep Impact. Therefore, ground-based telescopes can observe the thermal evolution of and the properties of the dust in the ejecta plume, and 8-10 m class telescopes will be required to search for water vapor using the non-resonant fluorescent lines at ~3 μm. The longer time scale evolution of the OH^- exosphere can be followed by telescopes around the world. The timing of the two impacts should allow for simultaneous observations from Hawaii, the Continental US, and from South America (e.g. Chile). We encourage astronomers to consider observing these impact events and the LCROSS team will make all efforts to provide the necessary information regarding the impacts to interested observers in a timely manner.

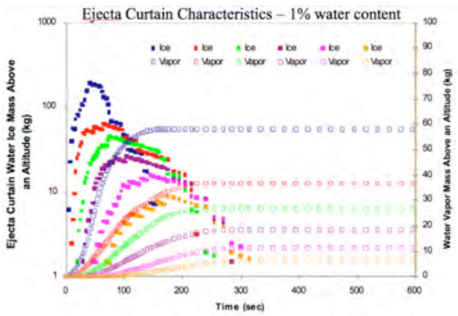

Figure 1. Current Best Estimate Impact Model (CBEIM) for ejecta curtain characteristics

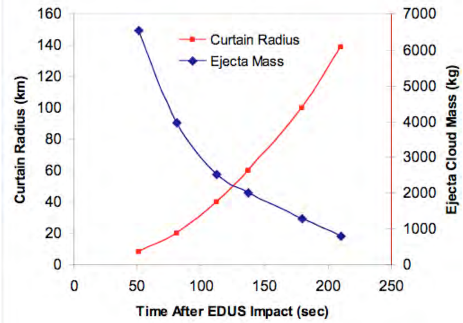

Figure 2. CBEIM for curtain radius and ejecta mass.