Effects of Surface Topogragphy on Dust Dynamics in the Lunar Plasma Environment. M. Piquette[1,3], M. Horanyi[1,2], and A. Lihkanski[4], [1]Laboratory for Atmospheric and Space Physics (LASP), Boulder CO, [2]Dept. of Physics, University of Colorado, Boulder CO, [3]Dept. of Astrophysical and Planetary Science, University of Colorado, Boulder CO, [4] Tech-X Corporations, Boulder CO.

Introduction: Due to interactions with the solar wind and solar ultraviolet radiation, the lunar surface develops a complex plasma environment, especially around geological features like craters. Various phenomenon have been observed taking place in this dusty plasma environment including dust levitation and even horizontal dust transport [1,2,3]. Observations of such phenomena have been recorded by the Surveyor 5, 6 and 7 cameras that show a 'horizon glow'. This glow has been explained by forward-scattered light off of levitating dust particles. Dust levitation and transport could also result in dust ponding, as has been observed on asteroid 433 Eros [4,5,6]. To understand these phenomena the lunar plasma environment is modeled with a particle-in-cell code and charged dust dynamics within the plasma environment is modeled via a test-particle approach, with a focus on how topography affects the overall dynamics.

Modeling the Plasma Environment: The plasma environment is driven by charging from the solar wind and photoemission from the lunar surface due to ultraviolet light. This study looked at two separate cases of topography, the first being a simple crater with a diameter of seven meters and another being the same simple crater with the addition of a 1x1x1 meter block on the rim. To model this plasma environment, a three-dimensional particle-in-cell code was ran using the commercial code, VORPAL©. The plasma was modeled with the solar zenith angle varying by 15° intervals from the surface normal for the two different topographies. Figures 1 and 2 show examples of the potential structure when the incident Ultraviolet radiation and solar wind is 45° from the surface normal for the crater and crater with block cases, respectively. The topography of the craters generate a complex potential structure that results in both vertical and horizontal electric fields.

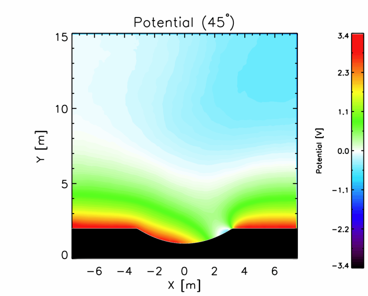

Figure 1

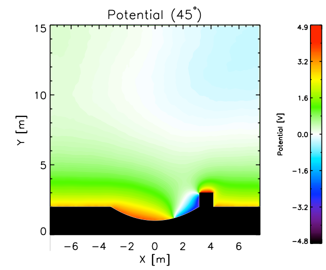

Figure 2

Dust Transport Simulation: Dust particles within these plasma environments are subject to four sources of current. These include photoemission from the grain itself and the collection of solar wind ions, solar wind electrons, and electrons that are photoemitted off the lunar surface [7]. If a dust grain possesses any net charge it will interact electrostatically with the lunar electric fields. Some dust grains are able to reach an equilibrium between gravitational and electrostatic forces; this results in a levitating effect and allows dust grains to move in very dynamic trajectories. These dynamic trajectories could result in a net transport of dust in or out of a crater.

To study this dust transport a two-dimensional dust tracing code was developed. We simulated multiple lunar days of dust dynamics by interpolating between the modeled plasma environments to match the local plasma conditions at a given time. During the simulation 25000 dust particles are parameterized with a position along the lunar surface and a random radius ranging from 10 nm to 10 μm. As time runs on in the simulation a random dust particle is launched off the surface at a rate of one grain per second and given the following initial parameters: A velocity of one meter per second, a charge of either -1, 0, or 1 elementary charge and a random launch angle between 45° and 135° from the surface. The simulation was ran for several lunar days allowing the dust distribution to come to an equilibrium.

By comparing the two different cases of topography we are able to qualify the effects that topography has on the plasma environment and dust dynamics.

Results: After allowing the simulations to come to equilibrium we found that both the plasma environment and dust dynamics are observably affected by the differing topographies. With the respect to the plasma environment, the electric fields observed see an almost ten fold increase in strength. Figure 3 shows the magnitude of the electric fields generated for the full lunar day for both cases of topography.

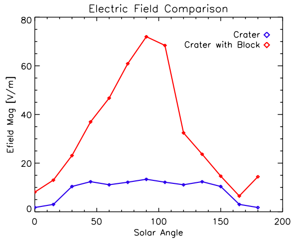

Figure 3

Dust dynamics above the surface also saw noticeable effects from the change in topography. During lunar sunrise and sunset the crater with block case saw a large increase in dust activity above the surface. This change in dynamics could help explain the horizon glow observed by Surveyor. Figure 4 shows the percent of dust above the surface for both cases of topography.

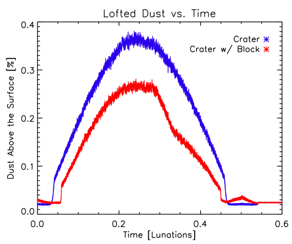

Figure 4

From these preliminary results, it's clear to see that even small changes in surface topography result in observable changes in local plasma conditions and dust dynamics

References: [1] Berg, O. et al., Preliminary Results of a Cosmic Dust Experiment on the Moon, *Geophys. Res. Lett.,* 1 (7), 1974; [2] Rennilson, J. and D. Criswell, Surveyor Observations of Lunar Horizon-Glow, *The Moon*, 10, 1974; [3] Colwell, J. et al., Lunar Surface: Dust Dynamics and Regolith Mechanics, *Rev. Geophys.*, 45, 2007; [4] Veverka, J. et al., Imaging of Small Scale Features on 433 Eros from NEAR: Evidence for a Complex Regolith, *Science*, 292 (484), 2001; [5] Colwell, J. et al., Dust transport in photoelectron layers and the formation of dust ponds on Eros, *Icarus,* 175, 2005; [6] Hughes, A. et al., Electrostatic dust transport on Eros: 3-d simulations of pond formation, *Icarus,* 195, 2008; [7] Horanyi, M., Charged dust dynamics in the solar system, *Annu. Rev. Astron. Astrophys., 34*, 383–418, 1996.