Toward understanding the lunar electrostatic environment in the vicinity of complex polar topography. M. I. Zimmerman[1,2] (michael.i.zimmerman@nasa.gov), W. M. Farrell[1,2], T. L. Jackson[1,2], and T. J. Stubbs[1,2,3] Goddard Space Flight Center, Greenbelt, MD, [2]NASA Lunar Science Institute, Ames Research Center, Moffett Field, CA, [3]Center for Research and Exploration in Science and Technology, University of MD, Baltimore County.

Introduction: Permanently shadowed regions (PSRs) are rich in complexity, due to the solar wind's interaction with the surface [1-3 and references therein]. For instance, mini plasma wakes are thought to form downstream of topographic obstructions, giving rise to electric fields that divert solar wind protons toward the surface [1-3]; diverted keV protons may sputter volatiles from the surface or implant to drive surface chemistry. In addition, the charge state of an astronaut suit or other exploration infrastructure is governed by the interplay between incident plasma currents (as modulated by wake formation) and tribocharging from frictional contact with the surface [1]. Results from ongoing computational plasma physics research at Goddard Space Flight Center are presented investigating the effects of complex topography on downstream wake formation, which feeds forward into quantifying exploration charging hazards and efforts related to prospecting for natural lunar resources.

Simulations: A combination of codes – one is open-source [4] and another has been developed solely at Goddard Space Flight Center – is used to simulate the solar wind flowing past various representative lunar topographic geometries. The solar wind is represented as a flowing collection of bunches of electrons and protons continuously resupplied upstream, and any particles incident on the surface contribute to the local surface charge as well as emitting secondary particles in some cases. The system evolves self-consistently according to the local electrostatic fields over many simulation timesteps, allowing detailed wake formation and quasisteady structure to be simulated in two spatial dimensions.

Results: Fig. 1 shows simulated proton fluxes downstream of step-like and inclined crater walls. In the former case, the primary contribution to the electric field is the ambipolar field at the wake flank (not shown). However, the inclined surface collects a significant number of electrons due to its proximity to the bulk solar wind, and a strong surface electric field develops which draw ions more swiftly toward the surface. Other geometries have been simulated, including arcing surfaces across a variety of spatial scales, as well as multi-step craters. First steps toward understanding and predicting the electrostatic environment within PSRs will be demonstrated through a comparison with simulation and theory, and implications for exploration hazards as well as volatile sequestration will be presented.

References: [1] Zimmerman, M. I. et al. (2012), *JGR*, in press, [2] Zimmerman, M. I. et al. (2011), *GRL, 38*, L19202, [3] Farrell et al. (2010), *JGR, 115*, E03004, [4] Verboncoeur et al. (1995), *Comp. Phys. Comm., 87*, 199.

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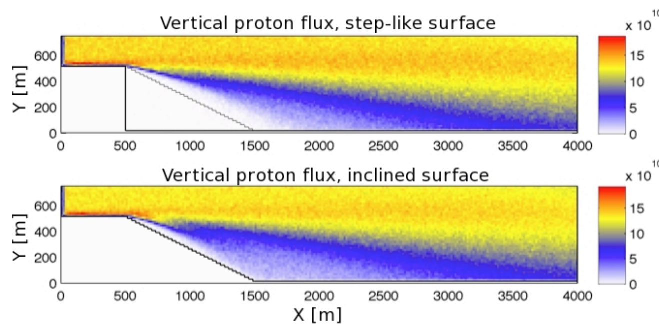

Fig. 1: Simulated proton flux downstream of (top) a step-like and (bottom) an inclined polar crater wall. The light gray inclined line in the top panel is the location of the surface from the bottom panel, provided for comparison.