MAPPING THE SURFACE POTENTIAL AND ION FLOW IN THE LUNAR SOUTH POLAR REGION.

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At the lunar terminator and polar regions, the solar wind bulk ion flow is primarily horizontal over the lunar surface. Local topography then acts to block or obstruct the plasma as it flows – creating voids in the solar wind immediately downstream of the obstacle.

A plasma expansion process is known to operate at the large (global) scale in the plasma void created downstream of the Moon itself [1]. Since the process is 'self-similar', the expansion will act at smaller scales as well – acting to fill in the voids crated by south polar topography [2-5].

Over the course of a lunation, the solar wind will flow overtop a polar crater or about a polar mountain in a direction that is defined by the local sun angle. There is thus an 'instantaneous' solar wind flow-obstacle configuration.

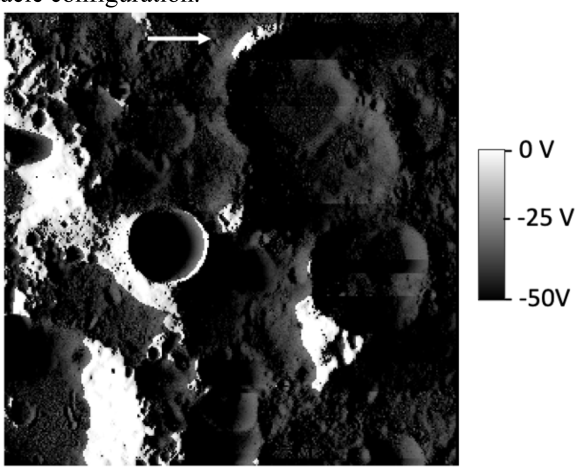

Figure 1- The modeled surface potential around Shackleton crater for an east-flowing solar wind.

Figure 1 is a predictive map of the surface potential expected in the Shackleton Crater region for solar wind flowing from the east (i.e., first quarter). In sunlit regions, the surface potential is derived based on surface current balance with photoelectrons and the solar wind. In shadowed regions, where the solar wind plasma is obstructed, the surface potential is derived via current balance of the plasma that has propagated into the crater via the ion sonic plasma expansion process and secondary emission process from the surface [2].

We will also present particle-in-cell simulations [3,4] that richly illustrate the ion sonic expansion process that should occur in polar craters and downstream of polar mountains. These codes provide further insight on the expansion process and the electrostatic fields that form to divert solar wind proton flow into the crater.

The lunation-integrated ion flux to the south polar crater floor has also been recently calculated [6]. At any instant, the leeward crater wall obtains the least influx, while the windward or far crater wall obtains a near full solar wind ion influx. The crater floor has an overall lower flux. However, over a full lunation, the leeward and windward walls reverse positions in the flow, but the floor in the central region of the crater still obtains relatively low solar wind ion influx in the expansion process. Figure 2 shows the lunation-averaged solar wind ion influx to four south pole craters (via the expansion process [5]).

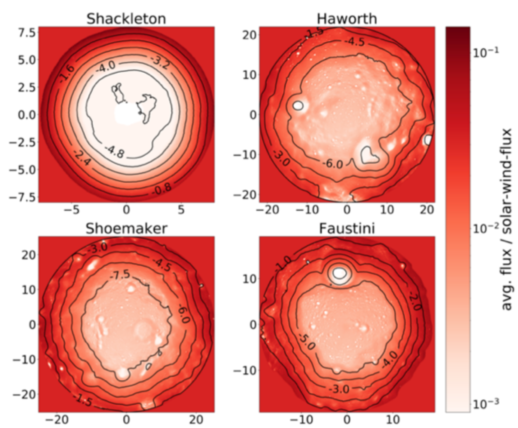

Figure 2. Solar wind ion influx into south polar craters [6].

There are numerous applications of these products: Maps of the surface potentials are indicative of the local plasma available for removing any charge buildup on human systems. Dissipation times are expected to be longer within plasma-starved polar craters [2]. Maps of ion influx into craters can be used to estimate hydrogen implantation sources and plasma sputtering losses to garner an understanding the stability of the icy-regolith found on south polar crater floors.

References. [1] Ogilvie, K. W., et al. (1996), Geophys. Res. Lett., 23, 1255-1258. [2] Farrell W. M. et al. (2010), J. Geophys. Res., 114, E03004. [3] Zimmerman, M. I. et al. (2011), Geophys. Res. Lett., 38, L19202. [4] Zimmerman, M. I. et al. (2013), Icarus, 992-998. [5] Rhodes, D. J. and W. M. Farrell (2019), J. Geophys. Res., 124, 4983-4993. [6] Rhodes, D. J. and W. M. Farrell (2020), Solar wind hydrogen flux in lunar south-pole craters, Planetary Sci. J., submitted.