**THE CHARACTER OF THE SOLAR WIND, SURFACE INTERACTIONS, AND WATER.** W. M. Farrell[1,2] and the DREAM Lunar Science Institute, [1]NASA/Goddard SFC, Greenbelt MD (William.M.Farrell@nasa.gov), [2]NASA Lunar Science Institute, Ames RC, Moffett Field, CA.

We discuss the key characteristics of the proton-rich solar wind and describe how it may interact with the lunar surface. We suggest that solar wind can be both a source and loss of water/OH related volatiles, and review models showing both possibilities.

Energy from the Sun in the form of radiation and solar wind plasma are in constant interaction with the lunar surface. As such, there is a solar-lunar energy connection, where solar energy and matter are continually bombarding the lunar surface, acting at the largest scale to erode the surface at 0.2 Angstroms per year
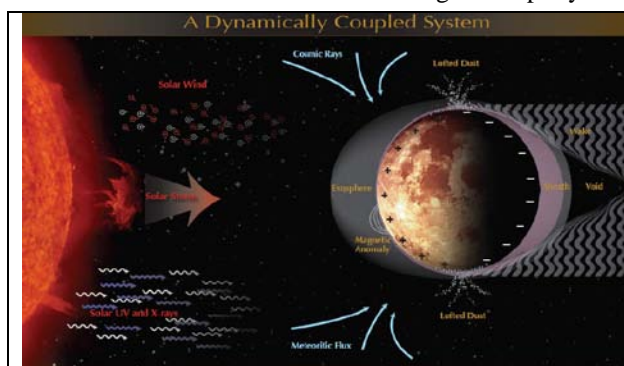
The solar-lunar energy coupling via solar radiation, solar wind plasma, and episodic solar storms

via ion sputtering [1]. Figure 1 illustrates this dynamically coupled Sun-Moon system.

The Solar Wind Plasma. The Sun emits a plasma from its corona called the solar wind. At 1 AU, this wind has a nominal density of 5 ions per cubic centimeter, a temperature of $\sim 10^5$K, and a flow speed of 400 km/sec. However, this solar wind is highly variable with densities & temperatures capable of changing by a factor of 5 and flow speeds by a factor of 2.

Solar Storms. The solar wind energy can become extraordinarily intense during a solar storm and associated coronal mass ejection (CME). A CME is a regional mass of plasma being ejected from the sun at high speeds (super-Alfvenic speeds). The driver gas typically has a collisionless shock ahead of it. This driver gas can also be 10-15 times denser than the nominal solar wind and contain a greater concentration of the heavy, highly-charged He^{++} than nominal solar wind.

Plasma/Surface Interactions. There are a number of ways the plasma interacts with the surface. First, there is an electrical connection. Plasma and photo-electron currents must all be balanced at the surface. As such, the lunar surface will become charged to create that current balance. On the photo-electron driven dayside, the surface charges positive but on the

nightside charges strongly negative in association with the trailing plasma void [2,3].

Second, there is an interaction in the form of a sputtering loss of regolith atoms via solar wind ions. In sputtering, incoming energetic ions transfer kinetic energy to the bound surface atoms, releasing surface material back into the space environment. There are really three types of sputtering [4]: momentum exchange, ionization, and chemical, and we will review all three and show examples of each class. There is also ion sputtering from the surface, where a solar wind ion releases an ion refractory species (like Si or Fe) [5].

Third, the solar wind electrons can act to release material via electron stimulated desorption processes [4]. At the heart of this process is a chemical interaction where the energetic electron alters the existing potential state of the surface-bound atom interaction. For example, a volatile loosely bound to the regolith could be affected by the chemical interaction of the solar wind electron of a few eV [6]. As we demonstrate, a challenge in understanding the electron interaction is the transition from the classical plasma physics picture to the quantum solid state picture.

The Water Paradox. Ironically, solar wind can be considered both a source and a loss for surficial water. Source mechanisms include the recombinative desorption process [6] and manufacturing via impact vaporization [7]. In this former case, solar wind protons incident with the surface take an O from the silica and form OH; the OHs then merging to create and release water. In the latter, a build-up of solar wind implanted hydrogen in the surface may be transformed to water using the energy in impact vaporization. However, water losses from sputtering should ever-present (especially on the dayside). As such, any water buildup must also be tempered by solar wind ion sputtering losses. We will provide an example from a polar crater model [8].

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