ACQUIRING "GROUND TRUTH" ABOUT THE DYNAMIC LUNAR ENVIRONMENT: IMPLICATIONS FOR SCIENCE AND EXPLORATION. T. J. Stubbs[1,2,3], W. M. Farrell[2,3], M. R. Collier[2,3], D. A. Glenar [4,2,3], D. T. Richard[5,3], T. L. Jackson[2,3], R. M. Killen[2,3], M. Sarantos[1,2,3], G. T. Delory[5,6,3], J. S. Halekas[6,3], and R. R. Vondrak[2,3], [1]University of Maryland, Baltimore County, MD, [2]NASA Goddard Space Flight Center, Greenbelt, MD, [3]NASA Lunar Science Institute, Moffett Field, CA. [4]New Mexico State University, Las Cruces, NM. [5]NASA Ames Research Center, Moffett Field, CA. [6]SSL, University of California, Berkeley, CA. Timothy.J.Stubbs@nasa.gov.

Background: As with many other airless bodies in the solar system, the surface of the Moon is directly exposed to the harsh space environment. It is irradiated by the unfiltered solar spectrum, perpetually peppered by space plasmas and energetic particles (e.g., the solar wind and galactic cosmic rays), and bombarded by meteoroids. These interactions produce a host of phenomena, including a multi-species exosphere, regolith/dust transport, surface charging, surface chemistry, and volatile transport (a water cycle?). These processes vary both spatially and temporally on the lunar surface, and in many cases are coupled together in complex ways. Despite recent ground-breaking discoveries by missions, such as LRO, Kaguya, and Chandrayaan-1, and theoretical developments, we are still in the early stages of being able to really understand the dynamically-coupled environment of the Moon.

Characterizing and understanding the lunar environment is clearly of intrinsic scientific interest, but it can also provide vital insights into the fundamental processes occurring at all airless bodies, such as Mercury, asteroids, and many of the outer planet moons. In this sense the Moon can be regarded as our "Rosetta Stone" for deciphering the rest of the solar system. Such insights are also invaluable for determining what science can be undertaken at/from the Moon, such as various types of astronomical observations.

Human exploration of the Moon during the Apollo missions was limited to near-equatorial regions during "lunar morning", and so did not experience the more hostile conditions that exist at other locations and times of lunar day. As well as the extremes in temperature, there are good reasons to believe that hazards, such as those associated with electrostatic discharges and dust adhesion, need to be adequately addressed in order to permit successful surface operations in the future.

Next Steps: The recent, current, and future orbital lunar missions have, or will, significantly increase our understanding of the lunar environment. Although a dedicated future orbital mission(s) to comprehensively study the lunar environment would undoubtedly make many major discoveries, we will focus on the crucial breakthroughs that could be made by acquiring "ground truth" with a suite of instruments deployed on the lunar surface (Table 1). Many of the crucial details of how fundamental lunar processes work cannot be adequately probed from orbit; for example, the subtle physics of the near-surface plasma sheath, or the size, charge, and velocity distribution of electrostatically transported dust.

Measurement:	**Possible Instrumentation:**
Surface electric fields	Electric fields boom
Plasma characteristics	Electron and ion Spectrometers
Energetic particles	Solid State Telescope
Ion species	Ion Mass Spectrometer
Neutral species	Neutral Mass Spectrometer
Magnetic field	Magnetometer
Dust mass, velocity and electric charge	Radio Frequency (RF) Detector
Exospheric dust concentrations	Photometer or CCD imager with filters (passive); LIDAR (active)

Table 1: Measurements and instrumentation for characterizing the dynamically-coupled lunar environment.

Ideally, several inter-calibrated instrument suites would be distributed across the lunar surface in order to investigate spatial and temporal variations, as well as the influence of geologically active sites and remanent crustal magnetic fields (Figure 1). Such an approach could be viewed as somewhat analogous to meteorological networks here on Earth, but geared toward the alien processes relevant to "lunar weather".

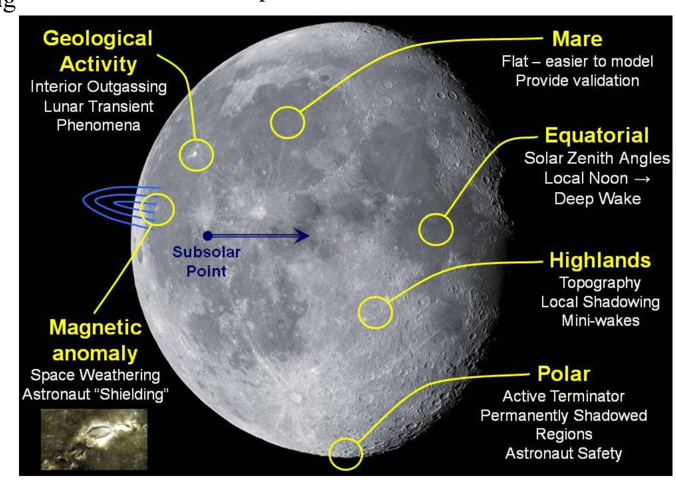

Figure 1: Options for the placement of a lander/network to characterize the dynamically-coupled lunar environment.