An ALSEP-like lunar surface science package in a cubesat form factor? P.E. Clark[1,3], J. Didion[2], R. Cox[3], [1]IACS, Catholic University of America, Washington, D.C. 20064, [2]NASA/GSFC, Greenbelt Road, Greenbelt, MD 20771, and [3]Flexure Engineering, 3518 Fremont Ave. N, #474, Seattle WA 98103. Contact Email: clarkp@cua.edu

Science Rationale: Although samples have been collected from the Moon, the 'dynamics' of the lunar environment itself have not been systematically studied. ALSEP packages deployed in the equatorial region during the Apollo era are no longer operational (except for passive retroreflectors), but they certainly gave indications of the nature of the fields and particle environment around the Moon. However, globally (in longitude and latitude) distributed identical instrument packages taking simultaneous measurements could provide systematic evaluation of the questions that have arisen about the dynamic nature of the lunar environment, the exosphere, dust and volatile transport, charging as a function of exposure to light, solar wind, and plasma, the nature of local and global fields. Particularly important is the capability of taking measurements for at least some portion of lunar night. These measurements should be provided before lunar landed exploration activities planned over the next decade have a significant impact on the environment. Such measurements will provide a much more comprehensive basis for understanding the protection needed for humans and robotic devices spending any length of time on the lunar surface. Because the lunar surface represents the range of conditions on most solar system objects and yet is far closer than other objects, it also represents an ideal technology testbed.

Background: In support of Project Constellation, we developed a design concept for an ALSEP-like stand-alone lunar surface instrument packages without dependence on radioisotope-based batteries [1]. An initial conventional attempt to design an environmental monitoring package with a solar/battery based power system led to a package with a unacceptably large mass (500 kg), over half of which was battery mass. We reduced the mass to 100 kg using radiation hard, cold temperature electronics and innovative thermal balance strategies using multi-layer thin reflective/insulting materials and gravity-assisted heat pipe, and were able to achieve a 10% duty cycle during lunar night.

Application: Here, we revisit this design concept with existing cubesat technology to be used in support of a fields and particles surface monitoring station. Packages based on the cubesat paradigm, standard platform and component with Class D development, acting as 'pathfinders' for environmental networks on the Moon or elsewhere, could be deployed robotically from lunar landers going to widely different latitude and longitude locations. Cubesat systems now being developed for deep space, including C&DH/ processing, communication and solar panel deployables, have components/subsystems capable of operating at colder temperatures and intrinsic radiation hardness. How scalable is the thermal design developed for the ALSEP-like LEMS (without RTGs or RHUs) concept for Project Constellation to a cubesat form factor package? Based on preliminary work, with state of the art thermal design, a 5 U payload of compact instruments could be supported in a 12 U package with cubesat deployables for power generation and communication. 3 U would be required for cubesat batteries. With alternative power storage systems under development, a larger payload might be possible.

References: [1] Clark P.E. et al. (2011) Small cold temperature instrument packages, SPESIF 2011, AIP Conference Proceedings, Physics procedia, 20, 300-307.