A lunar fiducial reference site to improve climate data records. Julian Gröbner and Louise Harra, Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center (PMOD/WRC), Davos, Switzerland. email: julian.groebner@pmodwrc.ch

Many essential climate variables and subsequent Climate Data Records (CDR) are derived from basic Level 1 radiance or reflectance measurements called Fundamental Climate Data Records (FCDR). The Global Climate Observing System (GCOS) criterion for a meaningful CDR requires decadal stability in measurements such as surface reflectance of better than 1 %. At present it is not unusual for individual satellite instruments to differ by several percent and therefore it is not possible to establish a decadal time-series of climate quality observations. Efforts to remove these instrument biases and improve post-launch uncertainties are a key focus of the Committee on Earth Observation Satellites (CEOS). The use of Earth based test-sites to act as fiducial reference for Earth Observing sites have been established recently. This concept applies this methodology to the moon.

Spatially uniform, bright and ideally stable land based targets typified by deserts are used to provide post-launch radiometric calibration/validation (Cal/Val) of Earth viewing satellite optical imagers. The key parameter for such a Cal/Val test site is the local surface reflectance which needs to be known with very low uncertainties and over a large spectral range in order to be used as fiducial reference for Earth Observing Satellites. Nevertheless, atmospheric corrections significantly limit the accuracy by which these test sites can be used to monitor the stability of the sensors on board satellites.
We propose to establish a Lunar Cal/Val test site to be used by Earth Observing Satellites as a Fiducial reference without the caveats of an intermediate atmosphere. The advantages of a lunar Cal/Val site are manifold:

- No intervening atmosphere between lunar surface and satellite
- Completely stable and inert surface
- Large scale homogeneous lunar surface (if a suitable landing site is chosen)
- Medium scale reflectivity characteristic for the average Earth viewing scene
- Predictable geometric Sun, Earth, Moon, Satellite constellation
- A single measurement (e.g. one space-walk) is sufficient to perform the reference surface reflectance measurements.

The necessary instrumentation would be a lightweight spectroradiometer measuring the solar and surface reflectance over the wavelength range from 300 nm to 2500 nm. The system is portable and would be operated by an astronaut. Several alternate measurements of the incoming solar irradiance and the radiation reflected by the lunar surface would be sufficient to determine the spectral lunar surface reflectance for the particular test-site close to the landing area.

Figure 1: *Symbolic picture of a surface reflectance measurement done with portable instrumentation (from SDMST.edu)*

Furthermore, a returned sample of lunar surface material could be used in a terrestrial laboratory to determine further reflectivity parameters, such as the bi-directional reflectance distribution function (BRDF) which would be an additional parameter to take into account when using the lunar surface as reference site.