Absolute Lunar Radiance Measurement Technique for CERES: Results and ERB Climate Stability Target Potential of the Moon

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Contributions from: Thomas C. Stone (USGS)
• Lunar Raster Scan Data
• Use of convolution integral technique
• Filtered radiance calculation
• Unfiltering Lunar Radiance to Irradiance
• Results
• The Moon as an ERB climate stability target
• Use of the technique to diagnose spectral darkening on future ERB instruments
• Summary
Example Lunar Radiance of 8 across 0.1 CERES pixel pitch

CERES PSF gives 10 counts per unit of overfilling radiance (i.e. GAIN=10)
Area in Blue = (Mean Lunar Rad) x (Width of Moon)

Area in Red = GAIN

Area in Green = [Area in Red] x [Area in Blue]
\[ K = \int_0^{2\pi} \frac{V(\theta^m, \phi^m)}{G \times \Delta\Omega^m} d\Omega \]
\[ h_p = \frac{\pi \int_0^{200} L_{th}(\lambda, T_s^p) d\lambda}{\int_0^{200} r_{tot}(\lambda)L_{th}(\lambda, T_s^p) d\lambda} \]

\[ d_p = \frac{\pi \int_0^{200} L_{th}(\lambda, T_s^p) d\lambda}{\int_0^{200} r_{wn}(\lambda)L_{th}(\lambda, T_s^p) d\lambda} \]

\[ R_p^{SW} = \frac{\pi U_p}{W_p} \times \left( K_{sw}^p - \int_0^{200} r_{sw}(\lambda)L_{th}(\lambda, T_s^p) d\lambda \right) \]

\[ R_p^{LW} = h_p \times \left( K_{tot}^p - \frac{\Gamma_p}{\pi U_p} \times R_p^{SW} \right) \]

\[ R_p^{WN} = d_p \times K_{wn}^p \]
CERES SW Lunar Flux Variation with Phase Angle at 1361 W/m² Solar Input

(a)

CERES LW Lunar Flux Variation with Phase Angle at 1361 W/m² Solar Input

(b)
Average CERES Lunar Albedo at 7° phase
(with 95% confidence limits)
Average CERES Lunar LW Flux at 7° phase and 1361 W/m² Solar Input (with 95% confidence limits)
SSF Edition3 Test run changes

**DAY Terra SSF Edition3 Test LW Flux % Nadir Direct Compare**

- allsky water (219.4 W/m²)
- desert (268.8 W/m²)
- clear water (257.6 W/m²)
- overcast (179.5 W/m²)

**NITE Terra SSF Edition3 Test Nite LW Flux % Nadir Direct Compare**

- allsky water (216.7 W/m²)
- desert (232.6 W/m²)
- clear water (252.5 W/m²)
- overcast (174.3 W/m²)
Average CERES Lunar WN Flux at 7° phase and 1361 W/m² Solar Input (with 95% confidence limits)
Ohring et al (2005) suggests that ERB measurement stability needs to reach 0.3% per decade.

This is near to an order of magnitude greater than CERES instrument design specification stability (note: not data products).
Standard Error of CERES Climate Calibration Trends
Measured using the Moon

% Decade Trend Standard Error

Time (years)

SW
LW
WN
Ohring et al. Target

NASA Langley Research Center / Science Directorate
Summary

• CERES (PFM SW scale) measures the Lunar Albedo to be 0.1362 (+/- 2-3%), all instruments agree on this figure within confidence giving validation to DCC unity technique.

• CERES measures the Lunar LW Flux to be 977W/m² (+/- 2-3%)

• LW ERB Ohring target reachable in 6 years using the Moon

• SW ERB Ohring target reachable in 12 years using the Moon (0.3%/decade 1σ reachable in 8 years)

• Technique can be used with over and under-filled telescopes e.g. imagers/CLARREO and CERES-II with the Sun