Spectral Response Functions for CERES Sensors

Susan Thomas, Kory Priestley
Mohan Shankar, Suzanne Maddock

CERES Instrument Group

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Radiance Determination

The measured radiance for a scene:

\[ \tilde{L} = \int_{0}^{\infty} L(\lambda) S(\lambda) \, d\lambda \]

- \( L(\lambda) \) – unfiltered radiance from the target scene
- \( S(\lambda) \) – spectral response of the sensor

The optical elements of the sensor include
- Primary and secondary silver mirrors
- Black paint on the active bolometer
- Filters in shortwave and window sensors
CERES Spectral Response

\[ S_j^\lambda = \rho_\lambda^2 \tau_\lambda \alpha_\lambda \mid j = \text{tot, sw, wn} \]

- \( \rho_\lambda \) is the spectral reflectance of the silvered mirrors
- \( \tau_\lambda \) is the spectral transmittance of any optical filters
- \( \alpha_\lambda \) is the spectral absorptance of the detector
CERES Spectral Response Function

Proto Flight Model

0.2 – 2.5 µm

2.5 – >100 µm

SWRS

Fourier Transform Spectrometer
CERES Spectral Characterization

• Measurements of the optical components in the 0.2 to 2.5 μm region are achieved using Cary 5 grating spectrometer with the witness samples.

• BIO-RAD Fourier Transform Spectrometer is used to measure the response in the region beyond 2.5 μm.
Shortwave Spectral Characterization

• Shortwave Reference Source (SWRS) uses 13 narrow-band filters in 0.4 to 2.0 micron region
• A Transfer Active Cavity radiometer (TACR) is used to place these narrow-band sources on same radiometric scale as the Narrow Field of View Blackbody (NFBB), the standard reference source.
• The relative spectral response at each SW spectral band is defined by ratioing the sensor and TACR measurements.
• Measurements of optical components are used to determine the spectral response for regions between these SW sources and to extend it below the 0.4 micron region.
CERES SW Spectral Characterization

Re-evaluation of SW optical components:

• Silver witness sample measurements from individual coating runs of the mirrors
• Consistency in tying silver measurements from different wavelength regions
• Band filter wavelengths were defined by combining SWRS lamp spectral output to the narrow band filter characteristics.
CERES FM1 and FM2 Sensors: Silver Measurements
# Radiance Comparison with Schiamachy Spectra

<table>
<thead>
<tr>
<th>Scene</th>
<th>Unfiltered Radiance</th>
<th>Filtered Radiance Original SRF</th>
<th>Filtered Radiance New SRF</th>
<th>Percent Change in Radiance</th>
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</thead>
<tbody>
<tr>
<td>Clear Ocean</td>
<td>21.4744</td>
<td>15.6414</td>
<td>15.6941</td>
<td>0.33</td>
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<tr>
<td>DCC</td>
<td>280.921</td>
<td>218.503</td>
<td>218.653</td>
<td>0.068</td>
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<td>Clear Snow</td>
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<td>78.9234</td>
<td>79.0018</td>
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<tr>
<td>Clear E-Forest</td>
<td>38.4567</td>
<td>29.3927</td>
<td>29.3987</td>
<td>0.02</td>
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