Initial Radiometric Calibration of the AWiFS using Vicarious Calibration Techniques

Mary Pagnutti
Science Systems and Applications, Inc.
John C. Stennis Space Center, MS 39529
228-688-2135
mary.pagnutti@ssc.nasa.gov

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Four selected targets of opportunity near Stennis Space Center are hundreds of meters across:

- Two gravel pit sand sites
- Large monoculture fields
- Cut grass amateur golf course
Selected Targets - Park Falls, WI

A target of opportunity was found near an Aerosol Robotic Network (AERONET) site near Park Falls

- Large grass field

AWiFS imagery (4,3,2)  
August 5, 2005

Landsat 7 imagery (7,4,2)  
August 5, 2005
Ground Reflectance Measurements

• ASD FieldSpec® FR spectroradiometer measurements of Spectralon® panels and several target areas were taken
  – ~50 m x 50 m area of a grassy field/golf course
  – ~100 m x 200 m area of a rye grass field
  – ~100 m x 100 m area of two sand sites

• Measurements were taken along transects aligned with the sensor azimuth
  – Measurements were taken at nadir and satellite elevation angles to account for BRDF effects
  – All measurements were taken while walking to increase spatial averaging
  – Periodic Spectralon panel measurements were taken

• All data were acquired within 40 minutes of satellite overpass
SSC Calibration and Characterization of ASD FieldSpec Spectroradiometers

- NASA SSC maintains four ASD FieldSpec FR spectroradiometers
  - Laboratory transfer radiometers
  - Ground surface reflectance for V&V field collection activities
- Radiometric Calibration
  - NIST-calibrated integrating sphere serves as source with known spectral radiance
- Spectral Calibration
  - Laser and pen lamp illumination of integrating sphere
- Environmental Testing
  - Temperature stability tests performed in environmental chamber
Novel Hyperspectral Sun Photometer

- Novel hyperspectral sun photometer is capable of acquiring measurements comparable to both ASRs and MFRSRs by making use of the laboratory radiometric calibration of the FieldSpec FR spectroradiometers
  - Optical Depth/Transmission
  - Diffuse-to-Global Ratio

- Sun photometer developed with fewer limitations than current sun photometers, utilizing equipment already used in the field
  - Radiometrically calibrated FieldSpec FR spectroradiometers
  - 99% reflectance Spectralon panels

- Measurements are made only at the time of overpass, thus reducing the impact of a changing atmosphere on the calculation of optical depth

### Sample Results

<table>
<thead>
<tr>
<th>Band</th>
<th>ASR 27</th>
<th>ASD</th>
<th>Difference</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>380 nm</td>
<td>0.588</td>
<td>0.598</td>
<td>-0.010</td>
<td>-1.74%</td>
</tr>
<tr>
<td>400 nm</td>
<td>0.495</td>
<td>0.485</td>
<td>0.010</td>
<td>1.99%</td>
</tr>
<tr>
<td>440 nm</td>
<td>0.366</td>
<td>0.321</td>
<td>0.044</td>
<td>12.14%</td>
</tr>
<tr>
<td>520 nm</td>
<td>0.224</td>
<td>0.198</td>
<td>0.025</td>
<td>11.25%</td>
</tr>
<tr>
<td>610 nm</td>
<td>0.161</td>
<td>0.156</td>
<td>0.005</td>
<td>2.91%</td>
</tr>
<tr>
<td>670 nm</td>
<td>0.108</td>
<td>0.100</td>
<td>0.008</td>
<td>7.26%</td>
</tr>
<tr>
<td>780 nm</td>
<td>0.07</td>
<td>0.069</td>
<td>0.001</td>
<td>1.33%</td>
</tr>
<tr>
<td>870 nm</td>
<td>0.049</td>
<td>0.050</td>
<td>-0.002</td>
<td>-3.58%</td>
</tr>
<tr>
<td>RMS 1:8</td>
<td></td>
<td>0.019</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>Camera</td>
<td>Overpass Time (UTC)</td>
<td>Satellite Elevation</td>
<td>Satellite Azimuth</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------</td>
<td>---------------------</td>
<td>--------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Mar 24, 2005</td>
<td>B</td>
<td>16:59</td>
<td>71.1 deg</td>
<td>285 deg</td>
</tr>
<tr>
<td>Apr 27, 2005</td>
<td>B</td>
<td>16:50</td>
<td>84.5 deg</td>
<td>285 deg</td>
</tr>
</tbody>
</table>

![Diagram for March 24, 2005]

![Diagram for April 27, 2005]
### Data Acquisitions – Park Falls, WI

<table>
<thead>
<tr>
<th>Date</th>
<th>Camera</th>
<th>Overpass Time (UTC)</th>
<th>Satellite Elevation</th>
<th>Satellite Azimuth</th>
<th>Sun Elevation</th>
<th>Sun Azimuth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 5, 2005</td>
<td>A</td>
<td>17:02</td>
<td>83.9 deg</td>
<td>103 deg</td>
<td>57.8 deg</td>
<td>149.7 deg</td>
</tr>
</tbody>
</table>

![Diagram of Overpass Satellite and Sun Position]

**Park Falls, WI, 8/5/05**
Green Band Calibration Summary

NASA Radiance = 
\[ \text{DN} \times (0.60 \pm 0.02) + (-5.49 \pm 5.36) \]

AW Radiance = \[ \text{DN} \times 0.51 \]

- AW Cal Curve
- SSC Cal Curve
- SSC Cal Curve ± 1σ
Red Band Calibration Summary

NASA Radiance = 
DN \times (0.46 \pm 0.01) + (2.60 \pm 3.89) 

AW Radiance = DN \times 0.40
NIR Band Calibration Summary

NASA Radiance = DN \times (0.31 \pm 0.02) + (-3.11 \pm 6.69)

AW Radiance = DN \times 0.28
SWIR Band Calibration Summary

NASA Radiance = DN \times (0.056 \pm 0.004) + (-2.816 \pm 2.151)

AW Radiance = DN \times 0.045
## Initial Radiometric Calibration

### Coefficients

<table>
<thead>
<tr>
<th></th>
<th>Green</th>
<th>Red</th>
<th>NIR</th>
<th>SWIR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NASA Estimate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cal Coeff (W/m² sr μm DN)</td>
<td>0.60 ± 0.02</td>
<td>0.46 ± 0.01</td>
<td>0.31 ± 0.02</td>
<td>0.056 ± 0.004</td>
</tr>
<tr>
<td>Offset</td>
<td>-5.49 ± 5.36</td>
<td>2.60 ± 3.89</td>
<td>-3.11 ± 6.69</td>
<td>-2.82 ± 2.15</td>
</tr>
<tr>
<td><strong>AWiFS Provided</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cal Coeff (W/m² sr μm DN)</td>
<td>0.51</td>
<td>0.40</td>
<td>0.28</td>
<td>0.045</td>
</tr>
<tr>
<td>Offset</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Green Band Calibration Summary

(Zero-Offset)

NASA Radiance = DN \times 0.58 \pm 0.06

AW Radiance = DN \times 0.51
Red Band Calibration Summary
(Zero-Offset)

NASA Radiance = DN ^ 0.47 ± 0.05

AW Radiance = DN ^ 0.40

Red Band Calibration Summary

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/24/05</td>
<td>Wiggins,grass</td>
</tr>
<tr>
<td>3/24/05</td>
<td>Wiggins,ryegrass</td>
</tr>
<tr>
<td>3/24/05</td>
<td>Wiggins,gravel(p)</td>
</tr>
<tr>
<td>4/27/05</td>
<td>Wiggins,gravel(d)</td>
</tr>
<tr>
<td>4/27/05</td>
<td>Wiggins,ryegrass</td>
</tr>
<tr>
<td>4/27/05</td>
<td>Wiggins,gravel(p)</td>
</tr>
<tr>
<td>8/5/05</td>
<td>Park-Fells,Field</td>
</tr>
<tr>
<td>8/18/05</td>
<td>UofA,Janpan</td>
</tr>
<tr>
<td>8/18/05</td>
<td>UofA,RRV</td>
</tr>
<tr>
<td>8/23/05</td>
<td>UofA,Janpan</td>
</tr>
<tr>
<td>8/10/05</td>
<td>UofA,RRV</td>
</tr>
<tr>
<td>8/22/05</td>
<td>SDSU,mowedgrass</td>
</tr>
<tr>
<td>8/22/05</td>
<td>SDSU,unmowedgrass</td>
</tr>
</tbody>
</table>

AW Cal Curve
SSC Cal Curve
SSC Cal Curve ± 1σ
NIR Band Calibration Summary

(Zero-Offset)

NASA Radiance = DN \times 0.30 \pm 0.02

AW Radiance = DN \times 0.28

March 16, 2006
SWIR Band Calibration Summary
(Zero-Offset)

NASA Radiance = DN * 0.052 ± 0.005
AW Radiance = DN * 0.045
## Initial Radiometric Calibration Coefficients (Zero-Offset)

<table>
<thead>
<tr>
<th>Band</th>
<th>NASA Team Estimate [W/m² sr μm DN]</th>
<th>AWiFS Provided [W/m² sr μm DN]</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>0.58 ± 0.06</td>
<td>0.51</td>
<td>12.1%</td>
</tr>
<tr>
<td>2 Red</td>
<td>0.47 ± 0.05</td>
<td>0.40</td>
<td>14.9%</td>
</tr>
<tr>
<td>3 NIR</td>
<td>0.30 ± 0.02</td>
<td>0.28</td>
<td>6.7%</td>
</tr>
<tr>
<td>4 SWIR</td>
<td>0.052 ± 0.005</td>
<td>0.045</td>
<td>13.5%</td>
</tr>
</tbody>
</table>

Percent difference is calculated by \(1 – \text{AWiFS/NASA Mean}\)
The NASA team of University of Arizona, South Dakota State University, and NASA SSC produce consistent results.

The AWiFS calibration coefficients agree reasonably well with the NASA team estimate.

The NASA team will continue to assess AWiFS radiometric accuracy.
Contributors

John C. Stennis Space Center, MS

National Aeronautics and Space Administration
Thomas Stanley

Science Systems and Applications, Inc.
Slawomir Blonski  Kelly Knowlton  Robert E. Ryan
Brennan Grant  Kenton Ross  Steve Tate
Kara Holekamp

Computer Sciences Corporation
Ronald Vaughan

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