RS CDS activities

J. McCorkel, K. Thome, B. McAndrew, A. Angal
Past seven months since last meeting has seen work on GLAMR calibration facility, Calibration Demonstration System (CDS) as well as Pathfinder activities

Coordinating and collaborated with other projects to optimize resources
- Collaboration with JPSS, team also leading laser-based characterization of J2 VIIRS
- NIST involvement

Improvements to laboratory calibration system
- Automation and robustness
- Demonstration of SWIR source and radiometers
GLAMR is required for improving instrument model parameterization

- Spectral/radiometric response
- Linearity
- Crosstalk
- Detector-to-detector differences
- Stray/scattered light
GLAMR Traceability Path

NIST Facility

POWR
Primary Optical Watt Radiometer

→

Stabilized laser source is used to transfer radiometric scale from POWR to portable transfer radiometer via another standard radiometer

→

LTD-11 #107 transfer radiometer

Sensor vendor facility

LTD-11 #107 transfer radiometer

→

Sphere Monitor

→

Satellite/airborne sensor
Traceability From NASA’s NIST-Calibrated Transfer Radiometers

*NIST is currently finalizing calibration of Si, IGA, and Extended IGA transfer radiometers that will be used for J-2 VIIRS*
NIST radiometric characterization of NASA transfer radiometer

POWR

L-1 DET-8 SN 107 Radiance Responsivity

Radiance Responsivity [A/(W/cm²/sr)]

Wavelength [nm]

800 1000 1200 1400 1600 1800

0.0E+0 1.0E-4 2.0E-4 3.0E-4 4.0E-4 5.0E-4 6.0E-4
Measurements For Radiometric Traceability

Traceability is transferred from a NIST transfer radiometer to the Sphere monitor during a laser sweep prior to VIIRS calibration.

Traceability is transferred from the Sphere to VIIRS during the spectral responsivity testing.
Sphere calibration transfers NIST traceability from transfer radiometers to sphere monitors that have fixed and permanent view of rear of sphere.

Sphere then placed in front of sensor to provide traceable, monochromatic extended source.

Concerns of this transfer include:

• Sphere loading
• View geometry effects
• Uniformity
Uncertainty from NIST radiometric characterization of transfer radiometers

<table>
<thead>
<tr>
<th>Uncertainty source (%)</th>
<th>300-400 nm</th>
<th>470-870 nm</th>
<th>895-991 nm</th>
<th>1001-1543 nm</th>
<th>1556-1643 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source-radiometer distance</td>
<td>-</td>
<td>-</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Geometry alignment</td>
<td>-</td>
<td>-</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
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<tr>
<td>Amplifier gain</td>
<td>-</td>
<td>-</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
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<tr>
<td>Reference irradiance cal</td>
<td>-</td>
<td>-</td>
<td>0.50</td>
<td>0.30</td>
<td>0.50</td>
</tr>
<tr>
<td>aperture</td>
<td>-</td>
<td>-</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Wavelength</td>
<td>-</td>
<td>-</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>E to L conversion</td>
<td>-</td>
<td>-</td>
<td>0.07</td>
<td>0.07</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Total (k=2)</strong></td>
<td><strong>0.55</strong></td>
<td><strong>0.11</strong></td>
<td><strong>1.04</strong></td>
<td><strong>0.66</strong></td>
<td><strong>1.04</strong></td>
</tr>
</tbody>
</table>
JPSS-2 VIIRS example

• JPSS-2 VIIRS laser-based characterization will take place summer 2016
  – Vendor site in southern California
  – NASA lasers primary
  – NIST system provides redundancy
  – Traceability relies on transfer radiometers characterized by NIST
VIIRS VNIR Channels, Red Dots Are 0.1% Points

0.001 points (J1 VIIRS prelim)

Laser key:

- **OPO-NIR-SHG**
- Dye R6G
- Dye DCM
- **Ti:Sapphire**

Backup: NIST
Backup: OPO-SWIR-SHG
2nd Backup: Ti:S OPO
Backup: dye table

<table>
<thead>
<tr>
<th>Channel</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>391</td>
<td>423</td>
<td>466</td>
<td>534</td>
<td>641</td>
<td>729</td>
<td>835</td>
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<tr>
<td>Wavelength</td>
<td>431</td>
<td>463</td>
<td>510</td>
<td>582</td>
<td>693</td>
<td>765</td>
<td>901</td>
</tr>
</tbody>
</table>

CLARREO SDT, 12 May 2016
VIIRS SWIR Channels, Red Dots Are 0.1% Points

- **VIIRS-8**: 1210–1266 nm, 57 nm span
- **VIIRS-9**: 1361–1390 nm, 30 nm span
- **VIIRS-10**: 1541–1665 nm, 125 nm span
- **VIIRS-11**: 2211–2304 nm, 94 nm span

0.001 points (J1 VIIRS *prelim*)

- **M8**: 1210, 1266
- **M9**: 1361, 1390
- **M10**: 1541, 1665
- **M11**: 2211, 2304

**Laser key:**
- **OPO-SWIR-Idler**
- **OPO-NIR-Idler**
VNIR Performance

Measurements with new Sphere

Ti:Sapphire Dye Lasers

OPO-NIR SHG OPO-SWIR

OPO-SWIR-SHG OPO-NIR-Idler Ti:Sapphire OPO

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SWIR Performance

Measurements with new Sphere Dye Lasers

Ti:Sapphire OPO-SWIR

Clareo SDT, 12 May 2016
Table 1 (OPOs)

https://www.flickr.com/photos/earthrightnow/25945190973/in/album-72157665047762664/
https://www.flickr.com/photos/earthrightnow/26534326985/in/album-72157665047762664/
Table 2 – Dye Lasers (DCM & R6G)
Table 3 (Ti:Sapphire)

MIRA Ti:Sapphire

Doubler goes here but is on the table to the right out of the photo

Coherent Verdi 18 pump

OPO
Table 4 (NIST’s OPO Backup)

- Paladin pump
- LBO OPO
- LBO OPO doubler
All packed for J2 VIIRS

Successful Pre-ship Review held on 5 May 2016 with laser team, sensor vendor team, JPSS project, and NIST
Suitcase SOLARIS-2 (SS-2)

SS-2 scan of CLARREO team before PPBE meeting

First scan with SS-2
FY17 Plans

• RS Instrument model development based on SS2
• Document laboratory calibration uncertainty below 1% (k=2) to 2.3 micrometers
• Absolute reflectance retrieval comparison to NIST standards to evaluate uncertainties
• Further measurements of solar and lunar irradiance in addition to field deployments
  – Repeatability of lunar retrievals
  – Absolute measurement of solar irradiance
• NIST-calibrated transfer radiometer data acquisition system completed to 2.3 micrometers
  – New SWIR laser on order (>4W 1.85-2.5 microns)
• Implementation of extended InGaAs transfer radiometers (characterization currently in progress at NIST with GSFC radiometers)