JPSS-1 VIIRS V2 “At-Launch” RSR, Comparisons, Impacts, Etc.

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RSR, Comparisons, Impact

• JPSS-1 V2 RSR
  – Pedigree/Analysis
  – Product

• Influence of RSR on SDR
  – Comparisons with SNPP
  – Detector dependence
JPSS-1 VIIRS RSR Version History: Version 0 (Beta)

2014

- Jul: J1 VIIRS in TVAC chamber including spectral measurements using SpMA (all bands)
- Aug: J1 VIIRS V0 (Beta) RSR Release (Raytheon analysis)
- Sept: J1 VIIRS spectral measurements (ambient) using T-SIRCUS (VisNIR bands only)

2015

- Feb: J1 VIIRS V0 (Beta) RSR Release (Raytheon analysis)
- Mar: J1 VIIRS V1 RSR Release (DAWG analysis)
- Apr: T-SIRCUS VisNIR band avg RSR and fusion with SpMA VisNIR Version 1 RSR, plus M13 CO2 correction
- May: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
- Jun: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
- Jul: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
- Aug: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
- Sep: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
- Oct: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
- Nov: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
- Dec: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)

2016
JPSS-1 VIIRS RSR Version History:

Version 1

2014

J1 VIIRS in TVAC chamber including spectral measurements using SpMA (all bands)

2015

J1 VIIRS V0 (Beta) RSR Release (Raytheon analysis)

J1 VIIRS spectral measurements (ambient) using T-SIRCUS (VisNIR bands only)

2016

J1 VIIRS V1 RSR Release (DAWG analysis)

T-SIRCUS VisNIR band avg RSR and fusion with SpMA VisNIR Version 1 RSR, plus M13 CO2 correction

J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
JPSS-1 VIIRS RSR Version History:
Version 2 “At-Launch”

- **2014**: J1 VIIRS in TVAC chamber including spectral measurements using SpMA (all bands)
- **2015**: J1 VIIRS V0 (Beta) RSR Release (Raytheon analysis)
  - J1 VIIRS spectral measurements (ambient) using T-SIRCUS (VisNIR bands only)
- **2015**: J1 VIIRS V1 RSR Release (DAWG analysis)
  - T-SIRCUS VisNIR band avg RSR and fusion with SpMA VisNIR Version 1 RSR, plus M13 CO2 correction
- **2016**: J1 VIIRS V2 “At-launch” RSR Release (DAWG analysis)
Measurements: Illumination Characteristics

**TSIRCUS sampling strategy at each wavelength**
- Light on detectors for 8-28 seconds ($D_{n\text{open}}$)
- Shutter closed (dark) for 8-28 seconds ($D_{n\text{closed}}$)

**SpMA (V1 - All Bands)**
- Slit illumination
- Polarized
- Spectral smile
- >30% source non-uniformity along-track
- Offline source monitoring
- 5 to 6 decades of VisNIR response
- Contiguous spectral sampling

**TSIRCUS (V2 – VisNIR Bands)**
- Flood illumination
- Unpolarized
- Spectrally flat
- <10% source non-uniformity along-track
- Realtime source monitoring
- 4 to 5 decades of VisNIR response
- “Picket-fence” spectral sampling
Analysis: 6 Steps to V2 Band Average

“Fused” VisNIR RSR

Meets T-SIRCUS 2% noise metric, calibrated and normalized

“Rogue” response data and “inconsistent” sweeps removed

Data Quality Stratification (by SNR)

High Quality Response Only from T-SIRCUS

Combined High Quality Response from T-SIRCUS with SpMA Response

Final Combined Band Average Response (low quality response set to 1E-10)
<table>
<thead>
<tr>
<th>Band</th>
<th>Specified Center (nm)</th>
<th>Measured Center (nm)</th>
<th>Specified 50% Bandpass (nm)</th>
<th>Measured 50% Bandpass (nm)</th>
<th>Specified Lower 1% Limit (nm)</th>
<th>Measured Lower 1% Limit (nm)</th>
<th>Specified Upper 1% Limit (nm)</th>
<th>Measured Upper 1% Limit (nm)</th>
<th>Specified IOOB (%)</th>
<th>J1 Measured IOOB (%)</th>
<th>S-NPP Measured IOOB (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>640 ±6</td>
<td>642.3</td>
<td>80 ±6</td>
<td>78.9</td>
<td>≥565</td>
<td>594.4</td>
<td>≤715</td>
<td>691.5</td>
<td>0.5</td>
<td>0.11</td>
<td>0.39</td>
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<tr>
<td>I2</td>
<td>865 ±8</td>
<td>867.4</td>
<td>39 ±5</td>
<td>36.5</td>
<td>≥802</td>
<td>842.7</td>
<td>≤928</td>
<td>892.3</td>
<td>0.7</td>
<td>0.12</td>
<td>0.52</td>
</tr>
<tr>
<td>I3</td>
<td>1610 ±14</td>
<td>1603.2</td>
<td>60 ±9</td>
<td>60.7</td>
<td>≥1509</td>
<td>1544.3</td>
<td>≤1709</td>
<td>1667.7</td>
<td>0.7</td>
<td>0.44</td>
<td>0.48</td>
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<tr>
<td>I4</td>
<td>3740 ±40</td>
<td>3747.6</td>
<td>380 ±30</td>
<td>387.5</td>
<td>≥3340</td>
<td>3474.1</td>
<td>≤4140</td>
<td>4015.2</td>
<td>0.5</td>
<td>0.16</td>
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<tr>
<td>I5</td>
<td>11450 ±125</td>
<td>11483.1</td>
<td>1900 ±100</td>
<td>1875.1</td>
<td>≥9900</td>
<td>10170.8</td>
<td>≤12900</td>
<td>13090.6</td>
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<td>0.08</td>
<td>0.06</td>
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<tr>
<td>M1</td>
<td>412 ±2</td>
<td>410.9</td>
<td>20 ±2</td>
<td>18.2</td>
<td>≥376</td>
<td>395.6</td>
<td>≤444</td>
<td>425.1</td>
<td>1.0</td>
<td>0.35</td>
<td>2.19</td>
</tr>
<tr>
<td>M2</td>
<td>445 ±3</td>
<td>444.8</td>
<td>18 ±2</td>
<td>17.0</td>
<td>≥417</td>
<td>429.2</td>
<td>≤473</td>
<td>457.7</td>
<td>1.0</td>
<td>0.52</td>
<td>0.93</td>
</tr>
<tr>
<td>M3</td>
<td>488 ±4</td>
<td>488.7</td>
<td>20 ±3</td>
<td>19.1</td>
<td>≥455</td>
<td>472.9</td>
<td>≤521</td>
<td>504.4</td>
<td>0.7</td>
<td>0.43</td>
<td>1.15</td>
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<tr>
<td>M4</td>
<td>555 ±4</td>
<td>556.5</td>
<td>20 ±3</td>
<td>18.1</td>
<td>≥523</td>
<td>540.2</td>
<td>589</td>
<td>573.7</td>
<td>0.7</td>
<td>0.37</td>
<td>3.65</td>
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<tr>
<td>M5</td>
<td>672 ±5</td>
<td>667.3</td>
<td>20 ±3</td>
<td>19.3</td>
<td>≥638</td>
<td>649.7</td>
<td>≤706</td>
<td>685.1</td>
<td>0.7</td>
<td>0.37</td>
<td>2.70</td>
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<tr>
<td>M6</td>
<td>746 ±2</td>
<td>746.2</td>
<td>15 ±2</td>
<td>13.4</td>
<td>≥721</td>
<td>734.2</td>
<td>≤771</td>
<td>758.2</td>
<td>0.8</td>
<td>0.40</td>
<td>1.64</td>
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<td>M7</td>
<td>865 ±8</td>
<td>867.6</td>
<td>39 ±5</td>
<td>36.5</td>
<td>≥801</td>
<td>842.8</td>
<td>≤929</td>
<td>892.5</td>
<td>0.7</td>
<td>0.16</td>
<td>0.62</td>
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<tr>
<td>M8</td>
<td>1240 ±5</td>
<td>1238.4</td>
<td>20 ±4</td>
<td>26.1</td>
<td>≥1205</td>
<td>1214.0</td>
<td>≤1275</td>
<td>1264.9</td>
<td>0.8</td>
<td>0.48</td>
<td>0.49</td>
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<tr>
<td>M9</td>
<td>1378 ±4</td>
<td>1375.8</td>
<td>15 ±3</td>
<td>14.5</td>
<td>≥1351</td>
<td>1362.0</td>
<td>≤1405</td>
<td>1390.0</td>
<td>1.0</td>
<td>0.41</td>
<td>1.01</td>
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<td>M10</td>
<td>1610 ±14</td>
<td>1603.8</td>
<td>60 ±9</td>
<td>60.2</td>
<td>≥1509</td>
<td>1545.7</td>
<td>≤1709</td>
<td>1667.6</td>
<td>0.7</td>
<td>0.43</td>
<td>0.46</td>
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<tr>
<td>M11</td>
<td>2250 ±13</td>
<td>2258.2</td>
<td>50 ±6</td>
<td>52.0</td>
<td>≥2167</td>
<td>2209.4</td>
<td>2333</td>
<td>2314.4</td>
<td>1.0</td>
<td>0.35</td>
<td>0.40</td>
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<tr>
<td>M12</td>
<td>3700 ±32</td>
<td>3697.9</td>
<td>180 ±20</td>
<td>194.8</td>
<td>≥3410</td>
<td>3519.1</td>
<td>≤3990</td>
<td>3893.8</td>
<td>1.1</td>
<td>0.33</td>
<td>0.34</td>
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<tr>
<td>M13</td>
<td>4050 ±34</td>
<td>4070.0</td>
<td>155 ±20</td>
<td>153.0</td>
<td>≥3790</td>
<td>3909.1</td>
<td>≤4310</td>
<td>4224.7</td>
<td>1.3</td>
<td>0.40</td>
<td>0.35</td>
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<td>M14</td>
<td>8550 ±70</td>
<td>8580.3</td>
<td>300 ±40</td>
<td>340.1</td>
<td>≥8050</td>
<td>8336.3</td>
<td>≤9050</td>
<td>8879.3</td>
<td>0.9</td>
<td>0.19</td>
<td>0.21</td>
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<tr>
<td>M15</td>
<td>10763 ±113</td>
<td>10730.9</td>
<td>1000 ±100</td>
<td>1001.7</td>
<td>≥9700</td>
<td>9916.9</td>
<td>≤11740</td>
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<td>0.35</td>
<td>0.40</td>
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<tr>
<td>M16A</td>
<td>12013 ±88</td>
<td>11882.8</td>
<td>950 ±50</td>
<td>914.6</td>
<td>≥11060</td>
<td>11104.1</td>
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<td>11883.0</td>
<td>950 ±50</td>
<td>934.5</td>
<td>≥11060</td>
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<td>0.38</td>
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<tr>
<td>M16</td>
<td>12013 ±88</td>
<td>11882.9</td>
<td>950 ±50</td>
<td>924.8</td>
<td>≥11060</td>
<td>11102.8</td>
<td>≤13050</td>
<td>12695.7</td>
<td>0.4</td>
<td>0.39</td>
<td>-</td>
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<tr>
<td>DNBMGs</td>
<td>700 ±14</td>
<td>693.1</td>
<td>400 ±20</td>
<td>381.1</td>
<td>≥470</td>
<td>487.8</td>
<td>≤960</td>
<td>906.9</td>
<td>0.1</td>
<td>0.00</td>
<td>0.00</td>
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<td>DNBLSGS</td>
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<td>391.4</td>
<td>≥470</td>
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<td>≤960</td>
<td>900.1</td>
<td>0.1</td>
<td>0.02</td>
<td>0.00</td>
</tr>
</tbody>
</table>

1M16 is an average of M16A and M16B.

1DNBMGS spectral characterization represents DNBHGS. DNBHGS not directly measured due to its high gain.
Summary: JPSS-1 VIIRS At-launch RSR

- JPSS-1 VIIRS RSR measurement and analysis program is complete, leading to the “at-launch” designation for the Version 2 (February 2016) release.
- Reductions in IOOB in VisNIR bands bring JPSS-1 VIIRS into compliance for these bands. Other minor non-compliances exist but are well characterized.
- Though the RSR are compliant on spectral position, there are differences in position/shape compared to SNPP.
V2 RSR Impact on SDR: RSB

Model spectra useful for simulating spectral influence on TOA reflectance
J1 vs SNPP VIIRS TOA Reflectance
Using forward model spectra with SNPP Oct 2011 and J1 V2 RSR
VIIRS Detector Dependence: Blue Ocean Model

- Non-telecentric design causes variation in detector spectral coverage
- Simulated TOA reflectances show detector dependence
VIIRS Detector Dependence: Grassland Model

- Non-telecentric design causes variation in detector spectral coverage
- Simulated TOA reflectances show detector dependence
VIIRS Detector Dependence: Desert Model

- Non-telecentric design causes variation in detector spectral coverage
- Simulated TOA reflectances show detector dependence
V2 RSR Impact on SDR: TEB

J1 vs SNPP VIIRS TOA Brightness Temperature

Simulated using Tropical Atmosphere with Oct 2011 (SNPP) and V2 (J1) RSR

Using Band Average RSR
TEB Detector Dependence from RSR

Tropical Standard Atmosphere Model

Graphs showing the dependence of TEB detectors on RSR, with data for detectors I4, I5, M12, and M13.
TEB Detector Dependence from RSR

Tropical Standard Atmosphere Model

![Images showing TEB Detector Dependence for M14, M15, M16A, and M16B.](image-url)
SNPP VIIRS Band I5 in the Indian Ocean
Day 2014080, 065522 UTC

Along track profile taken from position of green line in imagery

Even detectors (Red) ~0.10 K warmer

Along track profile
JPSS-1 VIIRS Version 2 RSR

Band M13

Relative Spectral Response

Wavelength (um)

Det 1
Det 5
Det 10
Det 16
Atmospheric Transmittance
Summary: JPSS-1 VIIRS RSR Influence on SDR

- Comparisons with SNPP
  - RSB TOA reflectance normalized difference mostly within 1% but as high as 4%
  - TEB TOA BT within about 50 mK

- Detector dependence
  - RSB TOA reflectance variation along focal plane up to 0.5% due to VIIRS non-telecentric optical design.
  - TEB detector striping similar to SNPP except M13 which appears larger.
JPSS-1 VIIRS RSR Availability

• JPSS-1 VIIRS At-launch RSR are awaiting approval for public release. Available now at password-protected NASA eRoom: [https://jpss-erooms.ndc.nasa.gov/eRoom/JPSSInstruments/VIIRSF2_JPSS1/0_38007](https://jpss-erooms.ndc.nasa.gov/eRoom/JPSSInstruments/VIIRSF2_JPSS1/0_38007)

• Band average and supporting detector RSR (Sensor order numbering), plus Readme and pptx with background information.