1st Look at VIIRS J-1 compared to S-NPP

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No fundamental design changes

Some development and implementation changes

Much improved – optical crosstalk
  - At the cost of Vis polarization
  - Tungsten oxide optics contamination is not present on J1

Worse performance on SWIR and DNB low-radiance linearity

J1 launch more than year away

Expect better quantitative performance description in CALCON 2016
Fundamental Design & Manufacturing Considerations S-NPP

- Primary concern was cross-talk (before launch)
  - Large optical component, also electrical components
  - Cross-talk effects captured in Relative Spectral Response curves
- Many researchers were wishing for fewer data compression strategies
- What is this thing called the Day-Night Band?
- On-orbit surprise – fore-optics contaminated with WOx in fabrication
S-NPP to J1 Cross-talk

- Common (in-family) Relative Spectral Response (RSR) functions
- Essentially common electronic effects (small and unchanged)
  - Captured in Relative Spectral Response characterizations
- Polarization track-direction dependence still present
  - Ray Trace models now capture most of this variability
- Large improvement in optical cross-talk
  - Angle Resolved Scatter (ARS) largely eliminated with super-polished filter substrates, “higher density” coatings and out of band rejection tuned to filter side facing sensor aperture
  - Unintended consequence is larger degree of linear polarization sensitivity, mainly in Vis bands
J1 VIIRS Band Average RSR: RSB (1 of 2)
J1 VIIRS Band Average RSR: RSB (2 of 2)
J1 VIIRS Band Average RSR: TEB

- M12
- I4
- M13
- M14
- M15
- M16A
- M16B
- I5
Polarization Comparison (peak) at -45° Scan Angle

DoLP for J1 Compared to S-NPP, -45° scan Angle

Wavelength (nm)

DoLP (%) 0 1 2 3 4 5 6
400 450 500 550 600 650 700 750 800 850 900

Data provided by Jeff McIntire, SSAI
Data Compression Strategies

- Same on J1 as S-NPP
  - Bow-tie deletion
  - Predictor band
  - On-board aggregation of single gain bands
  - On-board track aggregation to reduce track-direction spatial resolution
  - Rice Compression

- Evolution of Direct Broadcast content to optimize system utility
  - No changes on J1 compared to S-NPP
J1 M10 (1610 nm) Nominal Performance Aside 2\textsuperscript{nd} Order Fit

Analysis and Slide by Dave Moyer, Aerospace, Inc.
SWIR Non-Linearity for Low Radiance Scenes

- All 4 SWIR bands (1240 – 2250 nm) show similar behavior
  - Low radiance departure from smooth curve at higher radiance values
  - Appears best served with a split range pair of quadratic equations
  - Break for dual fitting range such that virtually all ocean scenes near coast need split range quadratic fitting range
- At-launch status is that split range will not be applied in operational (IDPS) code and data product
  - Split range may be applied in Oceans team
  - Turbid waters (common to coastal zone) fail the traditional NIR assumptions required for atmosphere correction over ocean (ACO)
  - Common alternate ACO uses SWIR bands needed to distinguish aerosol and Rayleigh components
DNB non-linearity at low radiance

- Sampling strategy involves 32 aggregation zones from Nadir to edge of scan, multiple frames used in each agg zone.
- Non-linear responses found in final 250 km toward edge of scan.
  - See next chart for one agg zone (~worst case).
- Effects minimized with extending agg zone at ~251 Km from edge to the edge.
  - Non-linear response minimized with alternate CONOPS.
  - Size of image pixel grows by about 2X in scan, less in track.
- Improved radiometry possible with split range calibration equation and that is NOT planned for the J1 at-launch algorithm.
Gain $G(x,y,t)$ Plotted vs. $dn Z(x,y,t)$ for Single Detectors in Agg Mode 29

Chart provided by Jim McCarthy, Stellar Solutions
Summary and Conclusions

- Fundamentally degradations in performance for J1 compared to S-NPP are
  - Polarization correction larger for oceans (low surface reflectance) scenes in Vis
    - Polarization may be needed to optimize aerosol computations
    - Particularly when working in deep blue
  - SWIR scenes for Ocean Color (atmosphere correction) will need to be handled with non-linear algorithm
    - And this will not be done in IDPS code and production
  - DNB edge of scan spatial resolution slightly degraded

- Expect further tuning of Direct Broadcast content to optimize operational and research applications of the J1 data set
Many have contributed to development of these materials.

Instrument Scientist is Kurt Thome, and his chief deputy is Joel McCorkel. Jim Butler is Project Scientist.

Government support team with Jim McCarthy, Mark Schwartz, Ed Clement, Craig Kent and Gene Waluschka are involved.

Raytheon El Segundo (Space and Airborne Systems) leads are Eric Johnson and Randy Huang.

Special DNB support from Steve Mills.

NASA NICST with Hassan Oudrari, Kwofu Chiang, Jeff McIntire, Jack Xiong, David Moyer, Janna Feeley and Tom Schwarting.

STAR contributors are Slawomire Blonski, Wenhui Wang and Junqiang Sun.

NIST, Steve Brown, continue to support development and implementation of T-SIRCUS.
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Meaning</th>
<th>Acronym</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACO</td>
<td>Atmospheric Correction over Ocean</td>
<td>MODIS</td>
<td>Moderate Resolution Imaging Spectroradiometer</td>
</tr>
<tr>
<td>Agg</td>
<td>Aggregation</td>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>ARS</td>
<td>Angle-Resolved Scatter</td>
<td>NICST</td>
<td>NASA Instrument Characterization Support Team</td>
</tr>
<tr>
<td>CALCON</td>
<td>Calibration Conference, SDL, USU, Logan UT</td>
<td>NIR</td>
<td>Near Infrared Bands</td>
</tr>
<tr>
<td>CONOPS</td>
<td>Concepts of Operation</td>
<td>NIST</td>
<td>National Institutes of Standards and Technology</td>
</tr>
<tr>
<td>Dn (also called little dn)</td>
<td>Digital number sensor response adjusted for dark response</td>
<td>nm</td>
<td>Nanometers</td>
</tr>
<tr>
<td>DNB</td>
<td>Day-Night Band</td>
<td>RSB</td>
<td>Reflected Solar Bands</td>
</tr>
<tr>
<td>DoLP</td>
<td>Degree of Linear Polarization</td>
<td>RSR</td>
<td>Relative Spectral Response</td>
</tr>
<tr>
<td>I (also I-Band)</td>
<td>Imagery Band (375 Km resolution at Nadir)</td>
<td>S-NPP</td>
<td>Suomi-National Polar Partnership</td>
</tr>
<tr>
<td>IDPS</td>
<td>Interface Date Processing Segment</td>
<td>STAR</td>
<td>Center for Satellite Applications and Research</td>
</tr>
<tr>
<td>J1</td>
<td>JPSS 1 (Mission or Spacecraft)</td>
<td>SWIR</td>
<td>Shortwave Infrared</td>
</tr>
<tr>
<td>J PSS</td>
<td>Joint Polar Satellite System</td>
<td>TEB</td>
<td>Thermal Emissive Bands</td>
</tr>
<tr>
<td>LGS</td>
<td>Low Gain Stage (daytime operations, DNB)</td>
<td>T-SIRCUS</td>
<td>Traveling-Spectral Irradiance and Radiance responsivity Calibrations using Uniform Sources</td>
</tr>
<tr>
<td>M (also M-band)</td>
<td>Moderate Resolution Band</td>
<td>VIIRS</td>
<td>Visible/Infrared Imaging Radiometer Suite</td>
</tr>
<tr>
<td>MGS</td>
<td>Mid Gain Stage (transition between day and dark night operations, DNB)</td>
<td>Vis</td>
<td>Visible (wavelength) bands</td>
</tr>
</tbody>
</table>