CrIS SDR Overview

Yong Han

CrIS SDR Science Team

STAR JPSS Science Team Annual Meeting
August 24-28, 2015
Outline

• SNPP/JPSS-1 Instrument and SDR Spec Overview
• Team Members
• S-NPP Product Overview
• JPSS-1 Readiness
• Summary
• Path Forward
CrIS System

CrIS instrument provides interferograms & calibration data

**CrIS**

NPP/J1

Interferogram

**CrIS**

SDR Product

LW band

Radiance Spectra

MW band

SW band

Ground SDR Processing

Science RDRs

SDR product
### CrIS SDR Specifications

#### CrIS scan, field-of-regard (FOR), field-of-view (FOV)

![Diagram of CrIS scan and FOR/FOV](image)

#### CrIS SDR specifications. Black – normal spectral resolution (NSR); blue – full spectral resolution (FSR)

<table>
<thead>
<tr>
<th>Band</th>
<th>Spectral Range (cm⁻¹)</th>
<th># of Chan.</th>
<th>Spectral Res. (cm⁻¹)</th>
<th>NEdN @287K BB (mW/m²/sr/cm⁻¹)</th>
<th>Radiometric Uncertainty @287K (%)</th>
<th>Frequency Uncertainty (ppm)</th>
<th>Geolocation Uncertainty (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LWIR</td>
<td>650-1095</td>
<td>713</td>
<td>0.625</td>
<td>0.14</td>
<td>0.45</td>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td>MWIR</td>
<td>1210-1750</td>
<td>433</td>
<td>1.25</td>
<td>0.06</td>
<td>0.58</td>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>1210-1750</td>
<td>865</td>
<td>0.625</td>
<td>0.085</td>
<td>0.58</td>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td>SWIR</td>
<td>2155-2550</td>
<td>159</td>
<td>2.50</td>
<td>0.007</td>
<td>0.77</td>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>2155-2550</td>
<td>633</td>
<td>0.625</td>
<td>0.014</td>
<td>0.77</td>
<td>10</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Number of FSR channels: 2211; Number of NSR channels: 1305
# CrIS SDR Team Members

<table>
<thead>
<tr>
<th>PI</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yong Han</td>
<td>NOAA/STAR</td>
</tr>
<tr>
<td>Hank Revercomb</td>
<td>U. of Wisconsin (UW)</td>
</tr>
<tr>
<td>Larrabee Strow</td>
<td>U. of Maryland Baltimore County (UMBC)</td>
</tr>
<tr>
<td>Deron Scott</td>
<td>Space Dynamic Lab (SDL)</td>
</tr>
<tr>
<td>Dan Mooney</td>
<td>MIT/LL</td>
</tr>
<tr>
<td>Degui Gu</td>
<td>NGAS</td>
</tr>
<tr>
<td>Dave Jonson</td>
<td>NASA Langley</td>
</tr>
<tr>
<td>Lawrence Suwinski</td>
<td>Exelis</td>
</tr>
<tr>
<td>Joe Predina</td>
<td>Logistikos</td>
</tr>
<tr>
<td>Carrie Root</td>
<td>JPSS/DPA</td>
</tr>
<tr>
<td>Wael Ibrahim</td>
<td>Raytheon</td>
</tr>
</tbody>
</table>
• Excellent instrument performances since the beginning of the mission
• Stable SDR product with radiometric and spectral calibration accuracies and noise performance exceeding requirements with large margins
• Successful transition normal spectral resolution (NSR) mode to full spectral resolution (FSR) mode on 12/4/2014
• Both NSR and FSR SDRs are routinely generated
• Both NSR and FSR SDRs are monitored with web-based ICVS

**SDR Processing Time Line**

**Beginning S-NPP CrIS measurements**
March, 2012

**CrIS transition to FSR mode**
Dec. 4, 2014

**NOAA IDPS**
Processing
Data on CLASS

---

**Normal mode SDRs**

**NOAA STAR**
offline processing

**Data:** [ftp://ftp2.star.nesdis.noaa.gov/smcd/xxiong](ftp://ftp2.star.nesdis.noaa.gov/smcd/xxiong)
• Excellent instrument performances since the beginning of the mission

**Variation of the difference is less than ±0.01**

• Large outliers are due to VIIRS quarterly nonlinearity tests
Red lines – FSR spectrum; black lines – IDPS NSR spectrum

From STAR
J1 CrIS Pre-launch CalVal Status

• Successfully completed environmental test campaign (instrument currently at BATC for spacecraft level testing)
• Determined the pre-launch version of the calibration coefficients and parameters
• Developed and delivered the first version of the J1 CrIS SDR algorithm/software
• Characterized the instrument performances with the pre-launch test data
• Addressed the only instrument science waiver for the LW FOV8 partial obscuration
• Made significant progress in improving SDR algorithm to reduce radiance ringing artifacts (updates to be delivered in December 2015)
• Completed initial version of J1 CalVal plan
J1 CrIS Pre- & Post-launch CalVal Schedule

- **Instrument Delivery**
  - Pre-launch Calibration Activities
  - TVAC Completion 12/2014

- **JPSS-1 Launch**
  - Pre-launch Preparation Activities
  - CrIS S/C Level Testing

- **First Light**
  - Sensor Activation Phase
  - L+60 days

- **ICV**
  - Sensor Early Orbit Check Out and Performance Optimization Phase
  - L+90 days

- **ICV**
  - Intensive Cal/Val Phase
  - L+180 days

- **Operational Mode**
  - Intensive Cal/Val Phase
  - L+360 days

- **Long Term Monitoring Phase**
J1 CrIS SDR Algorithm/Software Changes

- J1 SDR code & LUTs delivered in January, 2015, able to process both NSR and FSR SDRs
- An update will be delivered in December 2015

![Diagram](image.png)

- Load Data
  - Pre-process: sort EP, SciCalP & IFGM packets into sequences; truncate full resolution RDRs if needed
  - IFGM to raw spectra conversion
  - FCE Handling (currently disabled)
  - Nonlinearity correction
  - Lunar intrusion handling

- SDR Output
  - Quality Flag & Variable Settings
  - Geolocation Calculation
  - Residual ILS Correction
  - Self-apodization Correction
  - Spectral Resampling
  - Post-calibration Filter
  - Radiometric Calibration
  - Lunar intrusion handling

- I Part
  - 9 granules

- O Part
  - SDR Granule

- P Part
  - Update ICT, DS & ES sliding windows
  - CMO Build if needed

- J1 code change

---

*SCOSTEP I-Flag & Variable Settings*
J1 Algorithm Improves Calibration Uncertainty

Ringing artifacts are significantly reduced

From STAR
J1 CrIS Noise Performance

Similar to S-NPP: noise performance significantly better than specification
Long Term Repeatability Performance

From Exelis

Excellent long term repeatability
Radiometric Uncertainty Performance

CrIS J1 Radiometric Uncertainty

Spec Limits

Percent of 287K Radiance

0.01% 0.10% 1.00%

Wavenumber (cm\(^{-1}\))

Excellent Radiometric Uncertainty Performance

From Exelis
Instrument Line Shape Parameters Derived for Spectral Calibration

Instrument Line Shape parameters derived from TVAC data (UMBC):

<table>
<thead>
<tr>
<th>FOV</th>
<th>LW Y</th>
<th>LW X</th>
<th>MW Y</th>
<th>MW X</th>
<th>SW Y</th>
<th>SW X</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19266</td>
<td>19266</td>
<td>19173</td>
<td>19173</td>
<td>19125</td>
<td>19125</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>19313</td>
<td>0</td>
<td>19205</td>
<td>0</td>
<td>19209</td>
</tr>
<tr>
<td>3</td>
<td>-19209</td>
<td>19209</td>
<td>-19181</td>
<td>19181</td>
<td>-19141</td>
<td>19141</td>
</tr>
<tr>
<td>4</td>
<td>19261</td>
<td>0</td>
<td>19174</td>
<td>0</td>
<td>19177</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>-19219</td>
<td>0</td>
<td>-19142</td>
<td>0</td>
<td>-19167</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>19282</td>
<td>-19282</td>
<td>19184</td>
<td>-19184</td>
<td>19149</td>
<td>-19149</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>-19084</td>
<td>0</td>
<td>-19168</td>
<td>0</td>
<td>-19172</td>
</tr>
<tr>
<td>9</td>
<td>-19287</td>
<td>-19287</td>
<td>-19189</td>
<td>-19189</td>
<td>-19136</td>
<td>-19136</td>
</tr>
</tbody>
</table>

Neon Calibration: 703.45036

<table>
<thead>
<tr>
<th>Band</th>
<th>Y offset</th>
<th>X offset</th>
<th>dR</th>
</tr>
</thead>
<tbody>
<tr>
<td>LW</td>
<td>-601</td>
<td>-22</td>
<td>99</td>
</tr>
<tr>
<td>MW</td>
<td>-658</td>
<td>-10</td>
<td>-25</td>
</tr>
<tr>
<td>SW</td>
<td>-605</td>
<td>6</td>
<td>-63</td>
</tr>
</tbody>
</table>

The ILS parameters minimize the difference between observed and calculated spectra.
Non-linearity (NL) Correction Coefficients Derived for Radiometric Calibration

- NL correction coefficients derived from different methods (UW)
- NL correction is a critical step to reduce radiance errors and FOV-to-FOV difference

ECT view residuals without NL correction

ECT view residuals with NL correction

LW NL coefficients

MW NL coefficients
Summary

• S-NPP CrIS instrument and SDR performances have been in excellent status; no significant degradations have been detected so far
• Both normal and full spectral resolution SDR products are routinely generated, available to public
• J1 CrIS pre-launch performance exceeds specifications
• J1 SDR algorithm/software is a significant improvement over S-NPP’s
• There is no critical unresolved issue in both S-NPP and J1 CrIS missions
Path Forward

- **S-NPP**
  - Continuation of S-NPP CrIS FSR SDR processing
  - Continuation of CalVal; assessment of 5 years of CrIS instrument and SDR performances
  - SDR reprocessing
- **JPSS-1**
  - Algorithm improvement updates (to be delivered in Dec. 2015)
  - Further TVAC data analysis; ECT characterization (2015-2016)
  - Preparation of post-launch CalVal activities (2015-2016)
- **JPSS-2 and beyond**
  - Full spectral coverage (650 – 2760 cm\(^{-1}\); no gaps)
  - Smaller FOV size and larger FOV grid (e.g. 8 km FOV size and 5 x 5 FOV grid)