



**MEMORANDUM FOR:** The JPSS Program Record.  
**SUBMITTED BY:** Flavio Iturbide-Sanchez on behalf the CrIS SDR Algorithm Calibration and Validation Science Team.  
**CONCURRED BY:** JPSS Product Portfolio Manager Lihang Zhou.  
JPSS STAR Program Manager Alisa Young.  
**APPROVED BY:** JPSS Program Scientist Satya Kalluri.  
**SUBJECT:** SNPP CrIS SDR Beta/Provisional Maturity Status  
**DATE:** 07/20/2021

**Provisional maturity status declaration for CrIS SDR**

**Maturity Review Date:** 07/21/2021  
**Effective Date:** 07/13/2021 (Upload of Engineering Packet v41)  
**Operational System:** IDPS with Engineering Packet (EP) v41

**1. Background:**

Following the successful launch of the Joint Polar Satellite System (JPSS) Suomi National Partnership Program (SNPP) spacecraft on 28 October 2011, the Sensor Data Record (SDR) produced by the Cross-track Infrared Sounder (CrIS) was declared to have reached validated maturity in December 2013. For nearly ten years, SNPP CrIS has provided global hyperspectral infrared (IR) observations twice daily for profiling atmospheric temperature and water vapor which are critical for improving weather forecast accuracy out to seven days. CrIS data are also used to retrieve greenhouse gases, land surface and cloud properties. CrIS measures infrared spectra in three spectral bands: the long-wave IR (LWIR) band from 650 to 1095  $\text{cm}^{-1}$ , mid-wave IR (MWIR) band from 1210 to 1750  $\text{cm}^{-1}$  and short-wave IR (SWIR) band from 2155 to 2550  $\text{cm}^{-1}$ . Currently the instrument operates in full spectral resolution (FSR) mode providing a total of 2211 radiance channels. On 24 June 2019 SNPP CrIS was commanded to operate on its redundant electronic Side-2 following the failure of the MWIR band signal processor in March of that year. The switch to the Side-2 electronics successfully recovered the MWIR band and restored the full capability of the instrument.

On 21 May 2021, the SNPP CrIS Side-2 LWIR signal processor (SP) circuit card assembly (CCA) failed (held in reset mode) resulting in the permanent loss of the Side-2 LWIR band observations. Due to this anomaly, eventually, the Interface Data Processing Segment (IDPS) stopped producing SNPP CrIS calibrated observations in the form the SDR product. Root cause analysis indicates the most probable cause of the anomaly is similar to that of the MWIR failure on the primary Side-1 electronics in March 2019. Basically, after nearly ten years on orbit the LWIR signal processor reached its total ionizing dose (TID) or radiation. It is expected that the susceptibility to radiation seen in the SNPP CrIS sensor will be significantly reduced by the redesign of the signal processor circuitry implemented for the NOAA-20 and subsequent CrIS sensors.

While production of operational MWIR and SWIR SNPP CrIS SDR data would resume on 27 May 2021, the LWIR SDR data remained unavailable. The decision was made to return to the

primary Side-1 electronics to recover the LWIR band based on feedback from the user community and numerical weather prediction (NWP) centers in particular. While channels from both the LWIR and MWIR band are assimilated by NWP forecasts, the bulk of assimilated channels are taken from the LWIR band, and these channels provide the most significant impact. In this respect, NCEP assimilates 92 CrIS LWIR band channels, while ECMWF assimilates 111 CrIS LWIR band channels. In contrast, only 8 CrIS MWIR band channels are assimilated at NCEP and 37 MWIR band channels are assimilated at ECMWF. Presently, no CrIS SWIR band channels are assimilated at those two major NWP centers.

Lessons learned from the first successful electronics side switch in 2019 were implemented to expedite the process. On 12 July 2021 the switch to Side-1 electronics was initiated and the LWIR and SWIR bands were found to be functioning nominally. The SNPP CrIS SDR data became available in GRAVITE and CLASS on 12 July 2021. This began an intensive period of review and monitoring performed by the CrIS SDR team to quickly restore the CrIS SDR data to operational quality.

Evaluation of the first several days of SNPP CrIS SDR Side-1 data following the switch to Side-1 electronics demonstrated that it held the JPSS Beta Maturity level quality based on the assessment of the spectral, radiometric, and geometric performance.

The CrIS SDR Team consists and is supported by experts from NOAA, NASA, University of Maryland/ Cooperative Institute for Satellite Earth System Studies (CISESS), University of Wisconsin/ Space Science and Engineering Center (SSEC), University of Maryland at Baltimore County, L3Harris, and Logistikos. The team has been working intensively on instrument performance optimization and CrIS SDR calibration and validation following the switch to Side-1 electronics. This document contains the justification to transition the SNPP CrIS SDR product to the beta maturity level, the path forward toward the provisional and validated levels.

## **1. Maturity Stage Definitions:**

### **Beta Maturity**

1. Product is minimally validated, and may still contain significant identified and unidentified errors.
2. Information/data from validation efforts can be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose.
3. Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exist.

### **Provisional Maturity**

1. Product performance has been demonstrated through analysis of large, but still limited (i.e. not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
2. Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
3. Documentation of product performance, testing involving product fixes, identified product

performance anomalies, including recommended remediation strategies, exists

4. Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

## **2. Justifications for Declaring Provisional Maturity for SNPP CrIS SDR Data Products:**

After the switch to the SNPP CrIS Side-1 electronics on 12 July 2021, the CrIS SDR team members began the assessment and analysis of CrIS on-orbit data, including CrIS science RDR, telemetry RDR, diagnostic RDR, SDR, and GEO data products. Based on intensive evaluation and monitoring of CrIS data, the following assessments of the SNPP CrIS instrument and data products are given:

1. The SNPP CrIS Side-1 science telemetry is operating as expected with stabilized parameters.
2. The CrIS Cal/Val Science Team has concurred and decided to leave the LWIR interferogram zero-path-difference (ZPD) locations at 10614 for the reverse and forward directions. This is because the assessment of the ringing characteristics show good agreement between SNPP CrIS Side-1 in 2019 and 2021, which confirms that the small ZPD offsets observed after the recent side switch are not producing a significant artifact.
3. The performance of the SNPP CrIS SDR data product has been demonstrated globally over one week after successfully switching to Side-1 electronics;
4. On-orbit NEDN: all FOVs and operational bands are within the JPSS Level-1 requirements and comparable to previous SNPP CrIS performance on Side-1 (before 26 March 2019), and Side-2 (after 25 July 2019) as well as to NOAA-20;
5. Radiometric performance: radiometric FOV-to-FOV consistency observed for LW and SW bands is within 0.1 K. The SNPP CrIS FOVs show good radiometric agreement in the LWIR band, which implies there is no need to change the nonlinearity values in the EP v41;
6. Spectral performance: spectral offsets for relative and absolute for all three bands are all within  $\pm 2$  ppm. Spectral calibration assessment suggests that SNPP CrIS is operating as well as it did before the electronics side change;
7. Geolocation performance: in-track and cross-track geolocation accuracy are slightly degraded compared to the accuracy achieved with the Side-2 geolocation mapping angles in EP v40, but is consistent with the previous Side-1 performance and within the specification for all FORs;
8. SNPP CrIS SDR products have been reliably produced by IDPS since the side switch on 12 July 2021. No discrepancy reports (DR) have been submitted during this period;
9. Preliminary results from the NUCAPS Team, demonstrate that Temperature and Water Vapor profiles can be retrieved using SNPP CrIS Side-1 LWIR/SWIR observations, while meeting the JPSS Level-1 Requirements. Major impact is associated with the lack of MWIR observations, causing slight degradation in the temperature profile product, and more noticeable degradation in water vapor profile.
10. All data products are sufficient for qualitative or limited quantitative assessments and for potential operational use.

The detailed justifications for declaring SNPP CrIS SDR Provisional maturity is attached in the presentation. A summary is listed below:

- Intensive calibration and validation activities have been conducted by the CrIS SDR Algorithm Calibration and Validation Science Team after the Side Switch Activities Performed by OSPO



## *Read-me for Data Users*

Satellite Engineering and Operations and L3Harris from July 12-14, 2021.

- All planned activities have been Successfully Completed On-time.
- The SNPP CrIS Sensor is becoming stable after the side switch and no more sensor tuning activities have been recommended by the CrIS SDR Cal/Val Science Team.
- The SNPP CrIS Side-1 LWIR and SWIR bands are functional, while the MWIR band is non-operational.
- Comprehensive assessment results demonstrate the SNPP CrIS Side-1 SDR product meets the JPSS Level-1 Requirements. Calibration fine-tuning is being discussed at this time.
- The SNPP CrIS Side-1 SDR product meets the JPSS Beta Maturity Level and could transit to the Provisional Maturity Level after corresponding approval.
- The CrIS SDR Algorithm Calibration and Validation Science Team recommends the potential transition of the SNPP CrIS Side-1 SDR product to the JPSS Validated Maturity Level within 1-2 months.

### **3. SNPP CrIS Provisional Maturity SDR Data Product Caveats:**

MWIR data is not available for the SNPP CrIS Side-1 SDR product.

### **4. Path forward:**

The team will work diligently to continue with the following planned Cal/Val tasks to promote the CrIS Side-1 SDR product to validated maturity:

1. Continue monitoring the instrument long-term stability and performance, as well as the SDR data quality with corresponding feedback from Users.
2. Continue to inter-compare the instrument against other sensors (including the NOAA-20/CrIS, IASI, VIIRS, and ABI), in order to further assess the radiometric calibration (uncertainty/stability). At the Validated review this assessment will be reported to confirm the results reported in this review.
3. Continue assessing the instrument noise, radiometric, spectral and geolocation calibration, as well as the instrument yield rate.
4. Based on the instrument performance and quality of the SDR products over a long-term validation period, the transition to the Validated maturity level is planned. The initial recommendation is 1-2 months after reaching the JPSS Provisional maturity level.

### **6. Acknowledgements:**

Acknowledgement and thanks are extended to all individuals and organizations participating in the intensive Side Switch and Recovery Activities of the SNPP/CrIS Instrument, an example of Team Effort, Hard Work, Dedication and Professionalism: NOAA, NASA, University of Wisconsin, University of Maryland Baltimore County, L3HARRIS, Logistikos, Raytheon, MIT.

Additional information is available in the CrIS Algorithm Theoretical Basis Document (ATBD) and Maturity review briefings, which can be accessed at:

<https://www.star.nesdis.noaa.gov/jpss/Docs.php>

<https://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php>



*Read-me for Data Users*

Point of Contact:

Name: Flavio Iturbide-Sanchez, CrIS Cal/Val Science Team Lead

Email: [flavio.iturbide@noaa.gov](mailto:flavio.iturbide@noaa.gov)

Phone: 301-683-3572