Read-me for Data Users

MEMORANDUM FOR: The JPSS Program Record
SUBMITTED BY: Dr. Don Hillger, JPSS Imagery Team Lead
CONCURRED BY: JPSS Algorithm Management Project Lead Arron Layns
JPSS STAR Program Manager Lihang Zhou
APPROVED BY: JPSS Program Scientist Mitch Goldberg

LAYNS.ARRON.LOUISE.1376452367 Digitally signed by LAYNS.ARRON.LOUISE.1376452367 Date: 2019.03.26 10:31:31 -06'00'
ZHOU.LIHANG.1385204074 Digitally signed by ZHOU.LIHANG.1385204074 Date: 2019.03.21 09:46:07 -04'00'
GOLDBERG.MITCHELL.D.1365828624 Digitally signed by GOLDBERG.MITCHELL.D.1365828624 Date: 2019.03.26 12:40:34 -04'00'

SUBJECT: JPSS1 Product Validated maturity status
DATE: 08/22/2018

Validated maturity status declaration for Imagery

Maturity Review Date: **08/22/2018**
Effective Date: **08/22/2018**
Operational System: **IDPS, Version I2.1.02**

The JPSS Algorithm Maturity Readiness Review Board approved the release of the Imagery to the public with a Validated maturity level quality as of 22 Aug 2018 (effective date), based on JPSS Validation Maturity Review held on 22 Aug 2018 (http://www.star.nesdis.noaa.gov/jpss/Docs.php).

1. **Definition of Validated**:
    - Product performance has been demonstrated over a large and wide range of representative conditions (i.e. global, seasonal)
    - Comprehensive documentation of product performance exists that includes all known product anomalies and their recommended remediation strategies for a full range of retrieval conditions and severity level
    - Product analyses are sufficient for full quantitative and qualitative determination of product fitness-for-purpose
    - Product is ready for operational use based on documented validation findings and user feedback
    - Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument

2. **Algorithm Description**

The Imagery Environmental Data Records (EDRs) comprise a total of 12 products that create Imagery by placing appropriate pixels on a Ground Track Mercator (GTM) projection. All 5 I-bands, 6 M-bands (M1, M4, M9, M14, M15, M16; by default) and the Day Night Band (DNB) are created as Imagery EDRs. In the case of the DNB, the initial radiances are manipulated into a pseudo-albedo that adjusts for large solar and lunar zenith angle changes across the scan, with the resulting product being referred to as Near Constant Contrast (NCC) Imagery. This enhances the display, especially in terminator regions. Details on the GTM and the NCC process may be found in the Imagery ATBD.

The Collection Short Name (CSN) of these products are:

VIIRS-I1-IMG-EDR
VIIRS-I2-IMG-EDR
VIIRS-I3-IMG-EDR
VIIRS-I4-IMG-EDR
VIIRS-I5-IMG-EDR
VIIRS-NCC-EDR
VIIRS-M1ST-EDR
VIIRS-M2ND-EDR
VIIRS-M3RD-EDR
VIIRS-M4TH-EDR
VIIRS-M5TH-EDR
VIIRS-M6TH-EDR

The product requirements/exclusions, as stated in the L1RDS, are:

Attribute	Threshold	Objective
1. The Imagery EDR shall be delivered under all weather conditions, including any rain rate		
a. Horizontal Spatial Resolution for visible and IR Imagery bands		
1. Nadir	0.4 km	0.1 km
2. Edge of Swath	0.8 km	0.1 km
3. Night-time visual, Nadir	2.6 km	0.65 km
b. Horizontal Spatial Resolution for moderate resolution bands		
1. Nadir	0.8 km	NS*
2. Edge of Swath	1.6 km	NS*
c. Mapping Uncertainty		
1. Nadir	1 km	NS*
2. Edge of Swath	3 km	0.5 km
3. Night-time visual, Nadir	TBS*	1 km
d. Refresh for Visible and IR bands	At least 90% coverage of the globe every 12 hours	NS*

*TBS = To Be Supplied, NS = Not supplied

Quality flags for each of the I-band Imagery products are the same, and described in the Imagery Data Dictionary (DD). The below is from the I1 format description but holds for all of the I-band Imagery EDRs.

VIIRS I1-Band Imagery Product Profile - Quality Flags

Fields		
Name	**Data Size**	**Dimensions**

QF1_VIIRSIMGEDR	1byte(s)

Name	Granule Boundary	Dynamic	Min Array Size	Max Array Size
AlongTrack	Yes	No	1541	1541
CrossTrack	No	No	8241	8241

Datum

Description	Datum Offset	Unscaled Valid Range Min	Unscaled Valid Range Max	Measurement Units	Scaled	Scale Factor Name	Data Type	Fill Values	Legend Entries
Imagery Quality (Pixel Quality as determined by the SDR Calibration Quality. Dead Pixel Replacement: Individual bad pixels caused by a bad detector are filled as an average of the two adjacent detector pixels. Bad edge-of-scan pixels use the adjacent pixel value. If two adjacent pixels are dead, a fill value is used for each pixel.)	0	MIN_VAL	MAX_VAL	unitless	No		2 bit(s)	Name: Value	Name: Value Good: 0 Poor: 1 No Calibration: 2 Dead Pixel Replacement: 3
Pixel is Saturated	2	MIN_VAL	MAX_VAL	unitless	No		1 bit(s)	Name: Value	Name: Value False: 0 True: 1
Missing Data (Data required for calibration processing is not available for processing)	3	MIN_VAL	MAX_VAL	unitless	No		2 bit(s)	Name: Value	Name: Value All data present: 0 Earth View RDR data missing: 1 Cal data (Space View, Earth View, Cal View, Solar Diffuser) missing: 2 Thermistor Data Missing: 3
Out of Range	5	MIN_VAL	MAX_VAL	unitless	No		2 bit(s)	Name: Value	Name: Value All data within range: 0 Radiance out of range: 1 Reflectance out of range: 2 Both Radiance and Reflectance out of range: 3
Spare	7	MIN_VAL	MAX_VAL	unitless	No		1 bit(s)	Name: Value	Name: Value

The NCC EDR is similar.

VIIRS NCC Imagery Product Profile - Quality Flags

Fields

Name	Data Size	Dimensions
QF1_VIIRSNCCEDR	1byte(s)	

Name	Granule Boundary	Dynamic	Min Array Size	Max Array Size
AlongTrack	Yes	No	771	771
CrossTrack	No	No	4121	4121

Datum

Description	Datum Offset	Unscaled Valid Range Min	Unscaled Valid Range Max	Measurement Units	Scaled	Scale Factor Name	Data Type	Fill Values	Legend Entries
Imagery Quality (Pixel Quality as determined by the SDR Calibration Quality.)	0	MIN_VAL	MAX_VAL	unitless	No		2 bit(s)	Name: Value	Name: Value Good: 0 Poor: 1 No Calibration: 2
Pixel is Saturated	2	MIN_VAL	MAX_VAL	unitless	No		1 bit(s)	Name: Value	Name: Value False: 0 True: 1
Missing Data (Data required for calibration processing is not available for processing)	3	MIN_VAL	MAX_VAL	unitless	No		2 bit(s)	Name: Value	Name: Value All data present: 0 Earth View RDR data missing: 1 Cal data (Space View, Earth View, Cal View, Solar Diffuser) missing: 2 Thermistor Data Missing: 3
Out of Range - Calibrated pixel value outside of LUT threshold limits	5	MIN_VAL	MAX_VAL	unitless	No		1 bit(s)	Name: Value	Name: Value All Data Within Range: 0 DNB Radiance Out of Range: 1
Spare	6	MIN_VAL	MAX_VAL	unitless	No		1 bit(s)	Name: Value	Name: Value

		NCC Error (Processing error occurred while trying to produce NCC pixel)	7	MIN_VAL	MAX_VAL	unitless	No		1 bit(s)	Name / Value		Name / Value: False 0; True 1

There are no quality flags for the M-band Imagery EDRs.

Product evaluation/validation: The actual Key Performance Parameter (KPP) for Imagery is confined to north of 60^0 North latitude, which did not contain sufficient sunlight at the Provisional time frame (initially 10 Dec 2017 to 15 Feb 2018) to evaluate visible/reflected imagery over that region at the time of the Provisional review. That is no longer the case, as the Imagery Team and a series of users in Alaska have now had months of experience using, operationally, all Imagery products. Furthermore, the exploitation of the N20 Imagery now covers the globe, with widespread use of the Imagery for a myriad of purposes. As such, we can summarize each bands performance, as these products are now employed by many users for their specific needs.

I1: Good imagery, ready for operations
I2: Good imagery, ready for operations
I3: Good imagery, ready for operations, the striping present in the I3 SDR is correctly removed in the resulting I3 Imagery EDR by the Imagery algorithm, and does not appear in the official N20 I3 Imagery product (it will appear in locally produced I3 Imagery if not handled properly by their in-house algorithms)
I4: Good imagery, ready for operations
I5: Good imagery, ready for operations

M1ST (band M1): Good imagery, ready for operations, some minor striping can occur
M2ND (band M4): Good imagery, ready for operations
M3RD (band M9): Good imagery, ready for operations
M4TH (band M14): Good imagery, ready for operations
M5TH (band M15): Good imagery, ready for operations
M6TH (band M16): Good imagery, ready for operations

NCC: Good imagery, ready for operations, though stray light corrections are ongoing. These corrections will be updated approximately monthly through the end of 2018, after which it is expected the stray light will be adequately handled by an automated Look-Up Table (LUT) process within the DNB SDR processing. The DNB extended zone is not included in the NCC imagery, which removes the excessive sun glint present in some extended portions of the original granule. Outside of stray light, no other issues have been identified with the NCC Imagery.

The mapping of pixels to the GTM is working properly, for all Imagery products, as is the capability to track on the GTM which pixel was used from the originating SDR. Cross-granule processing is also working correctly. No artifacts were seen in any of the evaluated imagery tied to the mapping process. Multispectral imagery using the Imagery EDRs will work without further manipulation by users.

Product availability/reliability since Provisional was declared has been excellent. Issues in creating I4 and I5 Imagery were resolved by 23 Jan 2018, and are no longer a factor in product availability. All other Imagery has been available on a consistent basis, provided the SDRs had no issues, neither did the Imagery products. Note this applies to the IDPS (official) set of Imagery products, those generated by another source are not applicable to the Imagery stored on CLASS.

Algorithm performance for the Imagery EDR depends heavily on the quality of the input SDRs. The algorithms for placing pixels on to the GTM and for creating pseudo-albedos for NCC are quite stable. This was verified early after the data was being produced (Beta stage). The NCC algorithm was expected to shift nadir to the center of the image (it is not in the center of the DNB SDR due to the extended portion of the scan) and cut off where the extended portion exists, and it is doing exactly that. This maintains for the user the capability to use NCC as part of a multispectral display with the other Imagery EDRs without further handling by users.

There are no known, current issues with the official set of Imagery products. The presence of stray light was expected with the early NCC imagery, and the long-term plan to correct for it within the DNB SDR is on schedule. The NCC imagery will benefit from these corrections. It is expected to take approximately one year for all of the corrections to be in place, and the first few months have already been accomplished. Gradual improvements in the DNB SDR and NCC Imagery regarding stray light may be expected over the next few months.

The most obvious issue that could have impacted the imagery is the bad detector on I3. Detector #29 is bad, and causes excessively low radiances and reflectances in the I3 SDRs, often values of zero. When values are not flagged as bad (e.g. FILL), the Imagery EDR is unable to account for them, and they appear as striping in the I3 Imagery. However, this was addressed in the spring of 2018, and the affected scan lines are now properly flagged as bad. As such, the I3 Imagery product successfully removes the bad (FILL) values by using adjacent “good” radiances and taking an average to create a value that does not create visual distractions for Imagery users. However, users creating their own Imagery products must be aware these bad pixels and scan lines are still present in the I3 SDR. While the official JPSS Imagery products already remove this striping, users developing their own Imagery products will have to come up with their own methods of dealing with this issue.

3. Changes since last maturity stage

No changes have been made to the Imagery algorithm since the launch of N20, and therefore no changes have been made since Provisional was declared in February 2018. The Imagery LUTs also did not require any updates, as the values for the Gain Value Versus Scene Source Elevation (GVVSSE or “goosey”) tables used for SNPP are also applicable to N20. Updates to stray light mitigation LUTs tied to the DNB SDRs produced improvements in the NCC Imagery, and these will continue, as noted above.

4. **Review board recommendations**

   The board recommends all Imagery EDRs to have passed the Validated stage of evaluation.

5. **Path Forward/Future Plan**

   The Imagery will continue to be analyzed, with a focus on NCC with its stray light impacts, but long-term plans will now focus on user requests for the Imagery. Primary among them is the desire from users that Imagery use Terrain Corrected geolocation versus the current ellipsoid approach. This work has already begun. We also plan to pursue the possibility of having official Imagery products from all 16 M-bands, with a goal of having this capability in place by, if not before, the launch of JPSS2.

6. **Additional Items to note**

   The quality of the Imagery will always be dependent on the quality of the input SDRs. Other than the I3 bad detector, which the Imagery algorithm addresses, no known significant issues with the VIIRS SDRs exist, and these SDRs attained the validated stage prior to August 2018. Provided the SDRs on N20 maintain their current level of performance, the Imagery from N20 will provide exceptional support to user communities, just as SNPP continues to do so today.

   Additional information is available in the Imagery Algorithm Theoretical Basis Document (ATBD) and validation maturity review briefing, which can be accessed at:
   https://www.star.nesdis.noaa.gov/jpss/imagery.php

   Point of Contact:

Name: Dr. Don Hillger
Email: don.hillger@noaa.gov
Phone: 1-970-491-8498