MEMORANDUM FOR:	The JPSS Program Record
SUBMITTED BY:	JPSS VIIRS Surface Reflectance Team Lead, Yunyue Yu
CONCURRED BY:	JPSS Algorithm Management Project Lead Lihang Zhou
	JPSS STAR Program Manager Ingrid Guch
APPROVED BY:	JPSS Program Scientist Satya Kalluri

SUBJECT:	NOAA-21 Product Provisional maturity status
DATE:	01/25/2024

Provisional maturity status declaration for JPSS VIIRS Surface Reflectance

Maturity Review Date:	**01/25/2024**
Effective Date:	**11/01/2023**
Operational System:	**NDE/NCCF, Version v1r3/v2r0**

The JPSS Algorithm Maturity Readiness Review Board approved the release of the NOAA-21 VIIRS Surface Reflectance to the public with a Provisional maturity level quality as of 11/01/2023, based on JPSS Validation Maturity Review held on 01/25/2024.

1. Maturity stage definition (reference to the AMM webpage for maturity definition: http://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php)
   - Product is minimally validated and may still contain significant identified and unidentified errors.
   - Information/data from validation efforts can be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose.
   - Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists.
2. Algorithm Description:
   2.1 List of Products (Collection Short Name (CSN))
   - NOAA-21 VIIRS Surface Reflectance, Level 2 (version v1r3)
   - CSN: SurfRefl
   2.2 Product requirements/Exclusions (DPS)

Table 2-1 – Surface Reflectance Requirements

Attribute	DPS	Requirement/Threshold
Geolocation	JERD-2441	The algorithm shall produce a surface reflectance product with a horizontal cell size of 0.80 km for radiometric and 0.40 km for imagery bands.
Mapping uncertainty	JERD-2529	The algorithm shall produce a surface reflectance product with a mapping uncertainty, 3 Sigma, of the VIIRS SDR pixel geolocation uncertainty
Valid range	JERD-2530	The algorithm shall produce a surface reflectance product with a measurement range of 0-1. (Note 1)
Accuracy	JERD-2531	$0.005+0.05\rho$. (Note 2)

Precision	JERD-2532	0.005+0.05ρ. (Note 2)

Note 1: The actual retrieved range of Surface Reflectance is -0.1 to 1.6.

Note 2: The symbol ρ denotes the retrieved surface reflectance. The APU metrics are applicable in conditions of low-to-moderate atmospheric turbidity (AOT (0.55µm) x m <1) where m is the air mass. The performance is degraded for the SR at wavelengths lower than 0.55µm by at least a factor 2. The SR errors may also be higher under partly cloudy and snow conditions.

2.3 Quality flags (Table)

Table 2-2 - QF1 Surface Reflectance

Bit #	Meaning
7	(Empty)
6	Sun Glint 0: no sun glint detected 1: sun glint detected
5	Low Sun Mask 0: high 1: low
4	Day/Night Flag 0: day 1: night
2-3	Cloud Detection and Confidence 00: confident clear 01: probably clear 10: probably cloudy 11: confidence cloudy
0-1	Cloud Mask Quality (currently undefined) (obsolete, set to 00) 00: poor 01: low 10: medium 11: high

Table 2-3 - QF2 Surface Reflectance

Bit #	Meaning
7	Thin Cirrus Detected – Emissive Test (obsolete, set to 0, v1r3) 0: no cloud 1: cloud
6	Thin Cirrus Detected – Reflective Test (obsolete, set to 0, v1r3) 0: no cloud 1: cloud
5	Snow/Ice Flag 0: no snow/ice 1: snow or ice
4	Heavy Aerosol Mask 0: no heavy aerosol 1: heavy aerosol
3	Cloud Shadow Mask

	0: no cloud shadow 1: shadow
0-2	Land/Water Background 001: deep ocean 010: shallow water 011: land 100: snow 101: arctic 110: Antarctic and Greenland 111: desert

Table 2-4 - QF3 Surface Reflectance

Bit #	Meaning
7	Bad M10 SDR data 0: no 1: yes
6	Bad M8 SDR data 0: no 1: yes
5	Bad M7 SDR data 0: no 1: yes
4	Bad M5 SDR data 0: no 1: yes
3	Bad M4 SDR data 0: no 1: yes
2	Bad M3 SDR data 0: no 1: yes
1	Bad M2 SDR data 0: no 1: yes
0	Bad M1 SDR data 0: no 1: yes

Table 2-5 - QF4 Surface Reflectance

Bit #	Meaning
7	Missing Precipitable Water data 0: no 1: yes
6	Invalid Land AM input data 0: valid 1: invalid or over ocean
5	Missing AOT input data 0: no 1: yes

4	Overall Quality of AOT 0: good 1: bad
3	Bad I3 SDR data 0: no 1: yes
2	Bad I2 SDR data 0: no 1: yes
1	Bad I1 SDR data 0: no 1: yes
0	Bad M11 SDR data 0: no 1: yes

Table 2-6 - QF5 Surface Reflectance

Bit #	Meaning
7	Overall Quality of M7 Surface Reflectance Data 0: good 1: bad
6	Overall Quality of M5 Surface Reflectance Data 0: good 1: bad
5	Overall Quality of M4 Surface Reflectance Data 0: good 1: bad
4	Overall Quality of M3 Surface Reflectance Data 0: good 1: bad
3	Overall Quality of M2 Surface Reflectance Data 0: good 1: bad
2	Overall Quality of M1 Surface Reflectance Data 0: good 1: bad
1	Missing Surface Pressure input data 0: no 1: yes
0	Missing total column ozone input data 0: no 1: yes

Table 2-7 - QF6 Surface Reflectance

Bit #	Meaning
7	Unused
6	Unused
5	Overall Quality of I3 Surface Reflectance Data

	0: good
	1: bad
4	Overall Quality of I2 Surface Reflectance Data
	0: good
	1: bad
3	Overall Quality of I1 Surface Reflectance Data
	0: good
	1: bad
2	Overall Quality of M11 Surface Reflectance Data
	0: good
	1: bad
1	Overall Quality of M10 Surface Reflectance Data
	0: good
	1: bad
0	Overall Quality of M8 Surface Reflectance Data
	0: good
	1: bad

Table 2-8 - QF7 Surface Reflectance

Bit #	Meaning
7	Unused
6	Unused
5	Unused
4	Thin Cirrus Flag
	0: no
	1: yes
2-3	Aerosol Quantity
	00: climatology
	01: low
	10: average
	11: high
1	Adjacent to Cloud (currently undefined) (obsolete, set to 0)
	0: no
	1: yes
0	Snow Present
	0: no
	1: yes

2.4 Product evaluation/validation
- Preliminary validation shows the NOAA-21 SR meet the requirements and with a similar performance as NOAA20 and SNPP
- Downstream users (Vegetation index) feedback, no big issue found when use SR in VI/GVF product.

2.5 Product availability/reliability
- Available on AWS (noaa-nesdis-n21-pds/VIIRS_SurfaceReflectance_EDR), from 11/13/2023 to present.

2.6 Algorithm performance dependence
- SDR data quality, include the calibration data and geolocation data.

- Upstream product, AOD product, cloud mask/height, and GFS data
- Challenging atmospheric condition (e.g., heavy aerosol) and large solar/view angle will also impact the performance.

2.7 Known errors/issues/limitations

The product might have increased uncertainty for the misclassified dust aerosol model area.

3. Changes since last maturity stage

Compared with v1r2 SR, the updates of v1r3 include:

- LUT update using independent spectral response function.
- QFs update due the cloud mask version change.
- Minor change for the default aerosol model, from the dust model to generic model.

4. Review board recommendations

5. Path Forward/Future Plan

- Implement the mitigation algorithm for the dust aerosol model.
- Long term monitoring for NOAA-21 Surface Reflectance.
- Extensive and comprehensive validation for NOAA-21, including the inter-comparison with SNPP, NOAA-20 and other products.
- Collaborate with downstream users to understand the product performance and required improvement.

6. Additional Items to note.

Additional information is available in the VIIRS Surface Reflectance algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:

https://www.star.nesdis.noaa.gov/jpss/documents/ATBD/ATBD_SurfaceReflectance.pdf

Point of Contact:

Name: Yunyue Yu
Email: yunyue.yu@noaa.gov
Phone: 301-683-2566