MEMORANDUM FOR:	The JPSS Program Record
SUBMITTED BY:	JPSS VIIRS LST Team Lead, Yunyue Yu
CONCURRED BY:	JPSS Algorithm Management Project Lead Lihang Zhou
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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 LST Product

Maturity Review Date:	**01/25/2024**
Effective Date:	**01/25/2024**
Operational System:	**NDE/NCCF, Version #v2r2**

The JPSS Algorithm Maturity Readiness Review Board approved the release of the NOAA-21 VIIRS Land Surface Temperature to the public with a Provisional maturity level quality as of 01/25/2024 (effective date), based on JPSS Validation Maturity Review held on 01/25/2024 (link to review artifacts).

- Maturity stage definition (reference to the AMM webpage for maturity definition: http://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php)
  - Product performance has been demonstrated through analysis of a 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.
  - Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
  - Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
  - Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents
- Algorithm Description:
  2.1 List of Products (Collection Short Name (CSN))
  - L2 NOAA-21 VIIRS LST (version of v2r2)
  - L3 NOAA-21 VIIRS LST (version of v1r1)
    An enterprise algorithm (for the entire JPSS mission) was implemented for the NOAA-21 LST production. It is a traditional emissivity-explicit, split-window algorithm, with coefficients stratified for different atmospheric conditions (i.e. daytime/nighttime, total column of water vapor and satellite viewing zenith angles).

  2.2 Product requirements/Exclusions (DPS)

  Table 1. L2 and L3 VIIRS LST product requirements

Attribute	L2 Granule LST	L3 Gridded LST
Geographic coverage *Daily global Gridded Product required recently*	At least 90% coverage of the globe every 24 hours (monthly average)	Global coverage
Vertical Coverage		
Vertical Cell Size		
Horizontal Cell Size	0.8 km	0.009 degree
Mapping Uncertainty, 3 Sigma	1 Km at Nadir	
Measurement Range	213 – 343 K	213 – 343 K
Measurement Accuracy(bias)	1.4 K	1.4 K
Measurement Precision(1 sigma)	2.5 K	2.5 K
Refresh rate	Granule	Daily
Latency	96 minutes	30 hours

2.3 Quality flags (Table)

Table 2. L2 VIIRS LST Quality Flag

Bits	Long Name	Source	Description
1-0	LST quality	LST	00=high, 01edium, 10=low, 11=no retrieval
3-2	Cloud condition	Cloud mask	0=m 0=confidently clear, 01=probably clear,10=probably cloudy,11=confidently cloudy
4	SDR quality	SDR	0=normal, 1=bad data (bad quality or missing or out of space)
5	Aerosol Optical Thickness at 550 nm (slant path)	AOD	0=within range (AOD<=1.0);1=outside range (AOD >1 or AOD missing)
7-6	Land surface cover	land/sea mask snow/ice mask	00=land;01=snow/ice;10=in land water;11=coastal
9-8	Water vapor condition	Tpw input	00=very dry atmosphere(wv<1.5g/cm^2) ; 01= dry [1.5,3); 10=moist atmosphere[3,4.5); 11= very moist[4.5+)
10	Land surface Emissivity (LSE) quality	Emissivity	0=within LSE uncertainty, 1=beyond LSE uncertainty requirement (0.015)
11	Degradation by large viewing angle	SDR	0=no degradation, 1=large view degradation (VIIRS: <=40 degree)
12	Day/night flag	SDR	0=night (solar zenith angle > 85degree), 1=day
13	Thin cirrus	Cloud Mask	0= no thin cirrus, 1= thin cirrus (Only available for daytime)
14	Fire contamination flag	Cloud mask	0= no, 1= yes
15	Reserved		Reserved for future use

Table 3. L3 VIIRS LST Quality Flag

Bits	Long Name	Description
1 & 0	Data quality flag	00=high quality,01=Medium quality,10=low quality, 11=no retrieval
3 & 2	Cloud Confidence	00=confidently clear, 01=probably clear, 10=probably cloudy, 11=confidently cloudy
5 & 4	Land/water	00=land, 01=snow/ice, 10=in land water, 11=coastal/sea water
7 & 6	Empty	For future use

2.4 Evaluation/validation

Four methods, as shown below, have been used in the product evaluation/validation,

- Temperature based validation through the comparison with ground measurements from

SURFRAD, ARM, BSRN and NDBC network
- Inter-sensor comparison with S-NPP and NOAA-20 VIIRS LST
- Radiance based LST validation over multiple stations
- Cross-comparison with MODIS LSTs.

2.5 Product availability/reliability

The L2 NOAA-21 LST data stream started on May 29th, 2023 and L3 LST started on June 8, 2023, with some data missing due to the implementation on a non-operational system. It is expected to be more reliable after the operations begin in the NDE/NCCF system.

2.6 Algorithm performance dependence

The Algorithm performance depends on the quality of input datasets, such as sensor calibration, sensor noise, cloud mask, total column water vapor, and land surface emissivity. In addition, the LST retrieval quality may be degraded under conditions such as large view zenith angle, moist atmosphere, aerosols and cloud cover presence etc.

2.7 Known errors/issues/limitations

The new composition method has been applied in L3 NOAA-21 LST, while L3 NOAA-20 and S-NPP are still using the previous composition method. Inconsistency among the L3 VIIRS LST is observed. Further testing is needed once S-NPP and NOAA-20 apply the new update. In the meantime, we will monitor the NOAA-21 LST performance over a longer time period. We have identified issues with NOAA-21 GVF that will impact land surface emissivity, particularly for band 15 emissivity. However, this issue has been resolved since June 16, 2023. Furthermore, the limited availability of LST and emissivity data, along with the constraints of reference data, may affect the stability of statistical results in the validation.

3. Changes since last maturity stage
   None.
4. Review board recommendations

5. Path Forward/Future Plan
   - NOAA-21 LST LUT may need a tune-up
   - Comprehensive evaluation is planned using a longer time period of data.
   - Closely monitor the inconsistency among the VIIRS LSTs from SNPP, NOAA-20 and NOAA-21 resulting from the implementation of the new composition method.

6. Additional Items to note

Additional information is available in the JPSS VIIRS LST algorithm theoretical basis document (ATBD) and validation maturity review briefing, which can be accessed at:
http://www.star.nesdis.noaa.gov/jpss/Docs.php

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