

**VIIRS Land Surface Temperature (LST) EDR Release, Validated Stage 1 Data Quality
March 2015
Read-me for Data Users**

The JPSS Algorithm Engineering Review Board (AERB) released the VIIRS Land Surface Temperature Environmental Data Record (EDR) to the public with a Stage 1 Validation level maturity with an effectivity date of 7 Apr 2014, when the VIIRS LST_SWLST LUT Update (DR7493/474-CCR-14-1638) became operational. This assessment is based on both qualitative and quantitative analysis of the VIIRS LST EDR. The VIIRS LST EDR has been compared with U.S. SURFRAD, CRN observations and some other available ground measurements such as those in Africa and China. In addition the radiance based validation at granule level and the cross satellite comparisons with MODIS LST, SEVIRI LST products etc. have been performed.

Validated Stage 1 quality is defined as:

- Using a limited set of samples, the algorithm output is shown to meet the threshold performance attributes identified in the JPSS Level 1 Requirements Supplement with the exception of the S-NPP Performance Exclusions

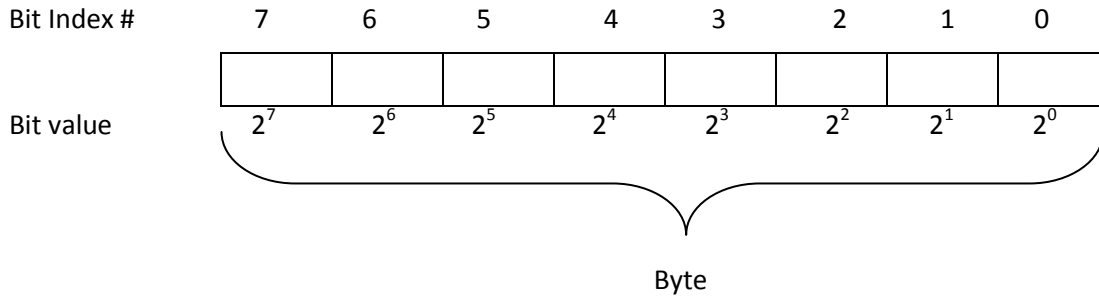
The Board recommends that users be informed of the following product information and characteristics when evaluating the VIIRS Land Surface Temperature EDR.

1. **Product Requirements:** Product requirements are now documented in the Joint Polar Satellite System (JPSS) Level 1 Requirements Supplement (L1RDS) and apply only to future satellites, starting with JPSS 1. Appendix D of the L1RDS describes performance exclusions for the Suomi NPP products.
2. **Algorithm Description.** The Suomi NPP VIIRS-LST-EDR is generated using split window algorithm; the dual split window algorithm is fallback therefore it is not in the operational production. The regression based algorithm coefficients are surface type dependent, referring 17 International Geosphere – Biosphere Programme (IGBP) types.
3. **Product Evaluation.** The VIIRS LST EDR meets the JPSS Level 1 requirements. This conclusion is based on over evaluation against a limited dataset of two and a half years from ground in-situ measurements such as US SURFRAD observations. And this is on a yearly basis which means that for a certain time period, a certain surface type, a certain ground site, the quality might be worse than that is defined in the requirement.
4. **VIIRS LST Data Description**
 - The VIIRS LST EDR is pixel level (~ 750 m) retrieval in a swath. Two granule products are available at user's choice: a single swath granule dataset with the dimension of 768x3200, and a 4-swath aggregated granule dataset with the dimension of 3072 X 3200.
 - The VIIRS LST is a scaled value ranging from 0 to 65527 stored as unsigned 16-bit integers with the corresponding scale and offset stored separately in the granule. The LST value beyond 65527 is fill value representing different reasons for non-retrieval.
 - Corresponding Geolocation data is available in a separate file (prefix of GMTCO) or packaged with the VIIRS LST data at user's preference in the configuration of CLASS.

- The current LST valid range is from 213K to 343K. The validated LST range is 265K to 320K.

5. Quality Flags.

- There are 3 separate quality flags in the VIIRS LST EDR stored in 8-bit unsigned char. Note that the bits in a quality flag is numbered from right (bit index #0) to left (bit index #7). A visual example of this format is shown below.



- The granule level metadata is included in the product under /Data_Products/VIIRS-LST-EDR_Gran_0.
- High quality is recommended for all LST applications but note that the high quality data only includes measurements within 40 degrees in viewing zenith angle.

Quality flag Details:

Byte	Bit	Flag Description Key	Result
0	0-1	LST Quality	Bit_1 Bit_0 0 0 = High 0 1 = Medium 1 0 = Low 1 1 = No Retrieval
	2	Algorithm	0 = 4-band dual-split window 1 = 2-band split-window
	3	Day/Night	0 = Night 1 = Day, ($0^\circ \leq \text{Solar Zenith Angle} \leq 85^\circ$)
	4	SWIR (M12 and M13) Brightness Temperatures	0 = both available 1 = at least one not available
	5	LWIR (M15 and M16) Brightness Temperatures	0 = both available 1 = at least one not available
	6	Active Fire	0 = no active fire 1 = active fire
	7	Exclusion – Thin Cirrus	0 = no thin cirrus 1 = thin cirrus
1	0	Clear Measurement Precision Degradation–	0 = no degradation 1 = degradation
	2-3	Cloud Confidence Indicator	Bit_1 Bit_0 0 0 = Confidently Clear 0 1 = Probably Clear 1 0 = Probably Cloudy 1 1 = Confidently Cloudy
	4	AOT Condition	0 = within range, ($\text{AOT} \leq 1.0$) 1 = outside range

	5	Horizontal Reporting Interval	0 = within Horizontal Cell Size, Nadir to 1.3 km
	6	Sun Glint	0 = None 1 = Present
	7	Terminator	0 = Beyond Terminator 1 = Inside Terminator,
2	0-2	Land/Water Background	Bit_2 Bit_1 Bit_0 0 0 0= Land and Desert 0 0 1= Land / No Desert 0 1 0= Inland Water 0 1 1= Sea Water 1 0 1= Coastal
	3-7	Surface Type	00001 = Evergreen Needleleaf Forests 00010 = Evergreen Broadleaf Forests 00011 = Deciduous Needleleaf Forests 00100 = Deciduous Broadleaf Forests 00101 = Mixed Forests 00110 = Closed Shrublands 00111 = Open Shrublands 01000 = Woody Savannahs 01001 = Savannahs 01010 = Grasslands 01011 = Permanent Wetlands 01100 = Croplands 01101 = Urban Built-Up 01110 = Croplands/Natural Vegetation Mosaics 01111 = Snow Ice 10000 = Barren 10001 = Water Bodies 11111 = Invalid IGBP Surface Type

6. **Known issues** of the VIIRS LST EDR:

- a. There are missing data in the bowtie deletion region.
- b. Regional biases may occur due to land surface cover difference and local atmospheric conditions.
- c. VIIRS LST tends to be colder than ground measurements over arid/semi-arid areas.
- d. Surface type misclassification is found to have a strong impact on VIIRS LST quality particularly that between surface types with distinct emission characteristics.
- e. Nighttime fresh/temporal snow/ice presence has been missing in the VIIRS surface type EDR so that VIIRS LST EDR has been using the static surface type for nighttime LST retrieval in regions with temporal snow, which may have significant impact on LST quality. This VIIRS Surface Type EDR problem is identified. A resolution on it can be in operational anytime after this release..
- f. Accuracy of the VIIRS LST data could be degraded due to cloud contamination since “clear sky” of the VIIRS cloud mask is defined as less than 10% cloud coverage.

7. **Future Work.** The NOAA JPSS VIIRS-LST-EDR team is conducting further validation and product improvement activities for Stage 2 validation maturity, include:
- a. Global/ Comprehensive validation of the VIIRS LST product. The team is extending the LST validation effort to different continentals and regions. Users involvements are warmly welcome.
 - b. Improvement of the LST retrieval algorithm is necessary to account for the emissivity change within a surface type. Therefore emissivity explicit algorithms are investigated for accurately reflecting the temporal emission variation feature of the land surface
 - c. Intensive monitoring of the current VIIRS LST production
 - I. Monitor the VIIRS LST product quality at spots (available ground in-situ network), regional and global scale.
 - II. Monitor the VIIRS LST product quality through the cross satellite comparisons.
 - III. Monitor possible impacts of latest changes in SDR, VCM, Surface Type EDR, and AOT on VIIRS LST quality.
 - d. Promotion of the VIIRS LST data usage in a variety of applications. User's feedback on their applications is greatly appreciated.

More information about VIIRS and VIIRS LST products can be found at the following websites, where users can find the Algorithm Theoretical Basis Document (ATBD), Operational Algorithm Description (OAD) document, Common Data Format Control Book (CDFCB) and user guide:

<http://www.star.nesdis.noaa.gov/jpss/>
<http://npp.gsfc.nasa.gov/documents.html>

The VIIRS Sensor Data Record (SDR) provisional quality Read-me document is available at:
<http://www.nsof.class.noaa.gov/saa/products/welcome>

VIIRS LST product is available for download at the above website under the "JPSS Visible Infrared Imaging Radiometer Suite Environmental Data Record (VIIRS_EDR) " category.

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