

**IDPS VIIRS Active Fire (AF) Application Related Product (ARP) Release, Validated Stage 1 Data Quality
January 2015 (updated on December 13, 2016)
Read-me for Data Users**

The JPSS Algorithm Engineering Review Board (AERB) released the Suomi NPP VIIRS Active Fire (AF) product to the public with a Stage 1 Validation level maturity with an effectivity date of August 13, 2014. The effectivity date corresponds to the Transition to Operations of IDPS Mx8.5, which included the implementation of multiple VIIRS Sensor Data Record (SDR) fixes. This assessment is based on both qualitative and quantitative analysis of the VIIRS Active Fire application related product for which the short name is “VIIRS-AF-EDR”. Quantitative evaluation is predominantly based on correlative analysis with the Aqua MODIS Thermal Anomalies and Fire product (MYD14). ***VIIRS-AF-EDR is at Stage 1 validation level with the caveat that spurious detections occur in a limited, but well-defined set of circumstances as described below.***

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-AF-EDR:

1. **Product Requirements:** Product requirements are now documented in the Joint Polar Satellite System (JPSS) Level 1 Requirements Supplement (L1RDS) and include a spatially explicit fire mask and fire radiative power (FRP) retrieval for the Active Fires product over the entire globe, including water. These requirements apply only to future satellites, starting with JPSS 1. Appendix D of the L1RDS describes performance exclusions for the Suomi NPP products. According to these exclusions, the **Suomi NPP product is required to deliver a list of locations of pixels with fire detections over clear land only.**
2. **Algorithm Description.** The Suomi NPP VIIRS-AF-EDR is based upon the MODIS (Moderate Resolution Imaging Spectroradiometer) Thermal Anomalies and Fire product Version 4 code, adapted for use with the VIIRS data. VIIRS-AF-EDR provides the latitude and longitude of pixels in which the algorithm detected hot targets, which are predominantly fires burning at the time of the observation. The Suomi NPP requirement exclusions reduce the requirements to the delivery of a list of pixel locations with fire detections over land, making them equivalent to the heritage requirements of the National Polar Orbiting Environmental Satellite System (NPOESS). The current IDPS product was designed to meet these heritage requirements and the Validated Stage 1 evaluation was also performed against these heritage requirements.
3. **Product Evaluation.** Quantitative evaluation to date is predominantly based on correlative analysis with the Aqua MODIS Thermal Anomalies and Fire product (MYD14). Though the VIIRS processing algorithm is an earlier version of the current MODIS algorithm, the differences do allow for product inter-comparison for validation analysis. Due to the high dependency of input SDR data, quantitative evaluation also includes the frequency of obviously spurious detections in the data product. Such spurious detections are identified based on the presence of detections over large, continuous segments of fire detections within single VIIRS scan lines.

Starting with the Beta release of the product on April 3, 2012, the product has been performing well in comparison to Aqua MODIS over significant evaluation periods, with the exception of spurious detections along VIIRS scanlines. Validated Stage 1 Maturity status is tied to the transition to operations of IDPS Build Mx8.5, which includes the implementation of 474-CCR-14-1667: VIIRS SDR Multiple Issues/Quality Flags & Calibration (ADRs 7110, 7111, 7112, 7227, 7313, 7448, 7449). Analysis showed that, as a result of this SDR code change, the frequency of spurious detections was further reduced to a limited set of circumstances and previous spurious detections observed over a 4-month period in Mx8.4 were removed by the Mx8.5 SDR algorithm.

4. **Quality Flags.** The product includes four bytes of quality flags (QFs) as listed in the table below. However, as only fire pixels are written to the sparse array of the current product, some of the bits, by default, are set to 0 or 1 for all pixels included in the output file (see comments below). Additional QFs describe observing and environmental conditions and results of various tests by the detection algorithm; advanced users are encouraged to analyze the need and applicability of these QFs for their particular application.

The bits describing the validity of the various fire tests (QF2, bits 0-6) are set only in several distinct configurations both daytime and nighttime based on the logic of the fire detection algorithm:

Daytime: Test 1 or (Test 2 and Test 3 and Test 4 and (Test 5 or Test 6))

Nighttime: Test 1 or (Test 2 and Test 3 and Test 4)

Users are recommended to use QF4 (Fire Detection Confidence) as the primary quality indicator of the product. The recommended classification of detection confidence is as follows:

QF4 <20% - low confidence;

20%<QF4<80% - medium confidence;

QF4>80% - high confidence.

It is not recommended to use Input Data Quality (QF3, bit 6) as it may not indicate the true overall quality of the input SDR data in some situations due to ongoing SDR changes. This bit is also currently set to "Poor" for all nighttime cases as well as some daytime cases.

QF	Bit	Description	Value	Comment
QF1	0	Adjacent Cloud Flag	0 = No 1 = Yes	Recommended for advanced use
	1	Adjacent Water Flag	0 = No 1 = Yes	Recommended for advanced use
	2-5	Search Window Size (number of pixels used)	1-10	Recommended for advanced use
	6	Sun Glint	0 = No 1 = Yes	Recommended for advanced use
	7	Sun Glint Override	0 = No 1 = Yes	Not to be used; set to 0 for all pixels
QF2	0	Fire Test 1 Valid	0 = No 1 = Yes	Limited use to assess algorithm performance
	1	Fire Test 2 Valid	0 = No 1 = Yes	Limited use to assess algorithm performance
	2	Fire Test 3 Valid	0 = No 1 = Yes	Limited use to assess algorithm performance
	3	Fire Test 4 Valid	0 = No 1 = Yes	Limited use to assess algorithm performance
	4	Fire Test 5 Valid	0 = No 1 = Yes	Limited use to assess algorithm performance
	5	Fire Test 6 Valid	0 = No 1 = Yes	Limited use to assess algorithm performance
	6	Input Data Quality	0 = Good 1 = Poor	Not recommended; all nighttime set to 1
	7	Day/Night	0 = Night 1 = Day	Recommended
QF3	0	False Alarm Override	0 = No 1 = Yes	Not to be used; set to 0 for all pixels
	1	Water Contamination Override	0 = No 1 = Yes	Not to be used; set to 0 for all pixels
	2-7	Spare Bits	Initialized to 0	Not used
QF4	0-7	Fire Detection Confidence	0 – 100%	Recommended as primary quality indicator

5. Known Errors.

- a. Spurious detections occur, with a frequency of approximately a few times a month, at high northern latitudes, presumably due to calibration mismatch at the beginning of a new VIIRS data transmission. The VIIRS SDR team is working on addressing the problem.
- b. Spurious detections may occur during lunar intrusion events along the edges of exclusion zones of the lunar intrusion contamination. Lunar intrusion events occur two times within each lunar cycle.

- c. A mismatch was detected between Radiance and brightness temperature, which has a small impact on detection performance. This issue is being worked by the VIIRS SDR team through 474-CCR--2321- VIIRS Radiance and Reflectance/Brightness Temp. Upper Bounds & QF Inconsistent (ADR 7294) scheduled for implementation in IDPS Mx8.9.
 - d. Additional spurious detections have occurred in data products generated within Direct Broadcast (DB) environments. Those errors are typically related to issues specific to DB data transmission and are not present in corresponding IDPS data. Producers of DB processing packages have implemented additional software to reduce or eliminate these additional spurious detections. **The DB-related issues do not impact the maturity of the IDPS product.**
6. **Future Work.** The next step in the VIIRS-AF-EDR product validation process is to perform product validation over additional samples of reference data from MODIS and limited airborne and in-situ data sets. Continuous long-term monitoring of the product is being carried out to track internal product consistency and spurious detections. Validation will also include expanded VIIRS-AF-EDR products under development to in order to meet the new Level 1 requirements for processing VIIRS data from the JPSS 1 satellite. These algorithm changes incorporate new MODIS Collection 6 algorithm components, and the tuning of the algorithm to VIIRS sensor characteristics.

More information about VIIRS and the VIIRS-AF-EDR product 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 product examples:

<http://www.star.nesdis.noaa.gov/jpss/>

Additionally, the VIIRS Sensor Data Record (SDR) Readme document s is available at:

http://www.star.nesdis.noaa.gov/jpss/documents/AMM/VIIRS_SDR_Validated_ReadMe.pdf

Points of Contact:

Ashley Griffin, Land JPSS Algorithm Manager
JPSS Data Products, Engineering and Services
Ahley.Griffin@nasa.gov

Ivan Csiszar, Product Lead
NOAA NESDIS STAR Land Discipline Team
Ivan.Csiszar@noaa.gov