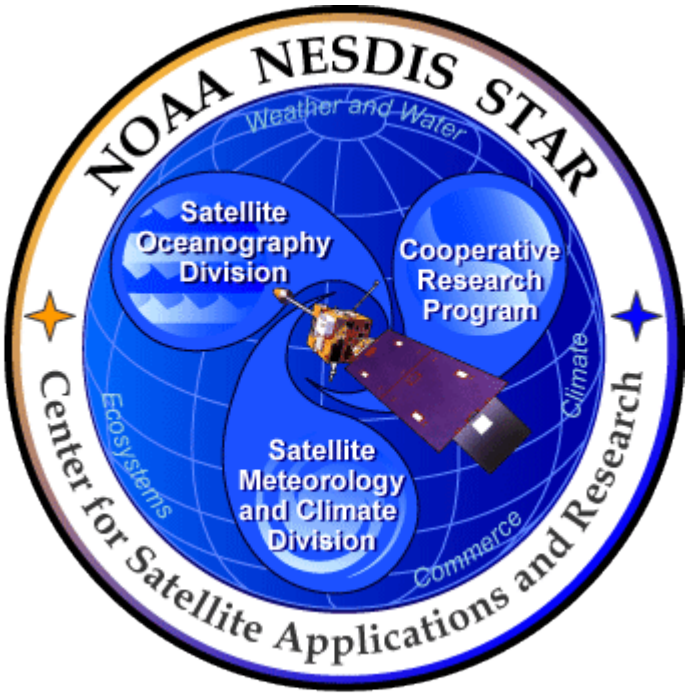

NOAA NESDIS
CENTER for SATELLITE APPLICATIONS and RESEARCH

The NOAA Suomi-NPP Data Exploitation (NDE) Active Fire Environmental Data Record (EDR)

External Users Manual

Version 1.6

TITLE: NDE ACTIVE FIRE EDR EXTERNAL USERS MANUAL VERSION 1.6

AUTHORS:

Ivan Csiszar (STAR)

Wilfrid Schroeder (UMD)

Louis Giglio (UMD)

Valerie Mikles (IMSG)

Marina Tsidulko (IMSG)

APPROVAL SIGNATURES:

_____ October, 2015
Walter Wolf (STAR) Date
STAR AIT Lead

DOCUMENT HISTORY
DOCUMENT REVISION LOG

The Document Revision Log identifies the series of revisions to this document since the baseline release. Please refer to the above page for version number information.

DOCUMENT TITLE: NDE Active Fire External Users Manual			
DOCUMENT CHANGE HISTORY			
Revision No.	**Date**	**Revision Originator Project Group**	**CCR Approval # and Date**
1.0	3/04/2015	Created by Ivan Csiszar	
1.1	3/11/2015	Modified by Ivan Csiszar	
1.2	3/11/2015	Modified by Valerie Mikles	
1.3	3/17/2015	Modified by Marina Tsidulko	
1.4	4/22	Integrated comment by Wilfrid Schroeder and Valerie Mikles	
1.5	6/4/2015	Modified by Ivan Csiszar	
1.6	10/26/2015	Modified by Ivan Csiszar and Marina Tsidulko	

LIST OF CHANGES

Significant alterations made to this document are annotated in the List of Changes table.

DOCUMENT TITLE: NDE Active Fire External Users Manual					
LIST OF CHANGE-AFFECTED PAGES/SECTIONS/APPENDICES					
Version Number	**Date**	**Changed By**	**Page**	**Section**	**Description of Change(s)**

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Page

1. PRODUCTS

This is an External Users Manual (EUM) document describing the operational NOAA NDE Active Fire (NDEAF) Environmental Data Record product and output file. The NDEAF product is a subset of the S-NPP VIIRS 750-m active fire product and was developed at the University of Maryland within the framework of the NASA Suomi-NPP Science Program. The work to transition the algorithm to NOAA operations was completed as part of the NOAA JPSS Product Development, Calibration and Validation program led by the NOAA NESDIS Center for Satellite Applications and Research (STAR). It will be delivered to the Suomi NPP Data Exploitation (NDE) team and integrated into the NDE Data Handling System (DHS) where it will be run in a pre-operational manner. After a preliminary testing period, the NDE DHS will, in turn, be delivered to the Office of Satellite and Product Operations (OSPO) to be run operationally.

The intended users of this EUM are end users of the operational output products and files, and the product verification and validation (V&V) teams. The purpose of the EUM is to provide product users and product testers with information that will enable them to acquire the product, understand its features, and use the data. External users are defined as those users who do not have direct access to the processing system (those outside of the OSPO and NDE). The output files are defined as those leaving the NDE DHS (running within ESPC) as opposed to those that are output by the NDEAF processing, but available only internally within the NDE.

1.1. Product Overview

1.1.1. Product Requirements

All NDEAF basic and derived requirements are available in the NDEAF Requirements Allocation Document (RAD). These requirements identify the users and their needs with respect to file content, format, latency, and quality.

1.1.2. Product Team

The NDEAF Development product team consists of members from STAR, the University of Maryland, and OSPO. The roles and contact information for the different product team members are identified in Table 1-1.

Table 1-1 Product Team Members

Team Member	Organization	Role	Contact Information
Ivan Csiszar	STAR	STAR Product Lead	5830 University Research Court Riverdale, MD. 20740 Phone: 301-683-3583 Email: Ivan.Csiszar@noaa.gov
Louis Giglio	UMD	Algorithm Scientist	2181 Samuel J. LeFrak Hall, College Park, MD 20742 Phone: 301-405-0064 Email: lgiglio@umd.edu
Wilfrid Schroeder	UMD	Algorithm Scientist	2181 Samuel J. LeFrak Hall, College Park, MD 20742 Phone: 301-314-1467 Email: wschroed@umd.edu
Walter Wolf	STAR	STAR Product Lead	5830 University Research Court Riverdale, MD. 20740 Phone: 301-683-1314 Email: Walter.Wolf@noaa.gov
Bigyani Das	IMSG	Development Lead	5825 University Research Court Riverdale, MD. 20740 Phone: 240-582-3585x23025 Email: Bigyani.Das@noaa.gov
Zhaohui Cheng	OSPO	Product Area Lead (PAL)	5830 University Research Court Riverdale, MD. 20740 Phone: 301-683-3233 Email: Zhaohui.Cheng@noaa.gov
Marina Tsidulko	IMSG	AIT Developer	5825 University Research Court Riverdale, MD. 20740 Phone: 240-582-3585x23027 Email: Marina.Tsidulko@noaa.gov
Jerry Guo	2020	OSPO Development	5830 University Research Court Riverdale, MD. 20740 Phone: 301-683-3269 Email: jerry.guo@noaa.gov
Jade Williams	EMCS	OSPO Development	5830 University Research Court Riverdale, MD. 20740 Phone: 301-683-3269

			Email: jerry.guo@noaa.gov
Valerie Mikles	IMSG	Requirements Developer	5825 University Research Court Riverdale, MD. 20740 Phone: 240-582-3585x23026 Email: Valerie.Mikles@noaa.gov
Yunhui Zhao	IMSG	Configuration Manager	5825 University Research Court Riverdale, MD. 20740 Phone: 240-582-3585x23028 Email: Yunhui.Zhao@noaa.gov
Qiang Zhao	IMSG	AIT Developer	5825 University Research Court Riverdale, MD. 20740 Phone: 240-582-3585 Email: Qiang.Zhao@noaa.gov
Donna McNamara		Data Distribution	NSOF 1372 4231 Suitland Rd Suitland MD 20746 Phone: (301)817-3803 Email; donna.mcnamara@noaa.gov

1.1.3. Product Description

The NDEAF product was developed to generate (1) a 2-dimensional array representing fire and thematic classes for each pixel (2) fire radiative power (FRP) for each pixel identified as “fire” by the fire detection algorithm. The algorithm processes all daytime and nighttime VIIRS pixels globally. Details on the content of all NDEAF external output files are shown in section 1.3.

1.2. Product History

The NDEAF is a new product in the operational NOAA JPSS environment, which in turn is and builds on the heritage Terra and Aqua MODIS AF products (MOD14/MYD14). This product replaces the current operational IDPS AF EDR product that delivers a sparse array of pixels detected as fire over land. The IDPS product meets the JPSS Level 1 requirements with the exclusions applicable for Suomi-NPP only. The new product meets the full set of JPSS Level 1 requirements, applicable for the AF EDR for the JPSS-1 satellite and beyond. It includes the geolocation and Fire Radiative Power (FRP) of pixels for which fires are detected, and a full mask consisting of a two-dimensional array of values representing fire and other relevant thematic classes (e.g., cloud) of each pixel in a swath

data granule globally over all land and water surface types. (A non-operational, science-quality version of the product is currently produced in a non-operational setting within NASA's Land Science Investigator-led Processing System - SIPS.) The NDEAF product is scheduled to go operational in NDE in late 2015.

1.3. Product Access

All NDEAF output data files will be made available by the NDE DHS on the NDE data distribution server at ESPC in a near real time manner. For access to this server, information about data files, and associated documentation, the NDEAF (i.e. Land) PAL should be contacted (see Table 1-1).

The NESDIS Policy on Access and Distribution of Environmental Data and Products is provided at: http://www.ospo.noaa.gov/Organization/About/access.html.
Users need to fill out the Data Access Request Form located on this site and submit to the PAL with a copy to nesdis.data.access@noaa.gov. This address provides the OSPO Data Access Team a copy of the correspondence. Once the request is approved by the OSPO management the data will be delivered by the Data Distribution System (DDSProd) currently distributing the ESPC data products and later by the Product Distribution and Access (PDA) system. The ESPC Data Distribution Manager, Donna McNamara (donna.mcnamara@noaa.gov) should be contacted for any data accessibility and data distribution problems. The data format is defined in the Table 1.2

In order to obtain the near real time data users needs to fill out the Data Access Request Form located on http://www.ospo.noaa.gov/Organization/About/access.html and submits to the PAL with a copy to nesdis.data.access@noaa.gov. CLASS will be archiving the NDEAF data products for distributing to the non-real-time users. NDE pushes the data to CLASS with the associated metadata in the standard formats. CLASS will archive the NDEAF product in netCDF4 format with associated metadata.

Table 1-2 lists the external distributed NDEAF files and their formats. Tables 1-3 to 1-5 show the detailed content of each output files listed in Table 1-2. Details of the Fire Tests listed in Table 1-5 are described in the NDE Active Fire Algorithm Theoretical Basis Document.

Table 1-2 NDE Active Fire Output Files

File	Description	Format	Size/file
AF_v1r0_npp_s?????????_e????????_c??????????.nc	This is the granule output file containing all the derived variables of the AF product.	netCDF4	11.7 MB/granule file + [number of fires] * 67 bytes / ~1008 files/day

Table 1-3 NDE Active Fire File

Name	Type	Description	Dimension	Units	Range
fire mask	8 bit integer	Fire mask	3200 x 768	unitless	0 - 9
algorithm QA	32 bit Integer	Fire algorithm QA mask	3200 x 768	unitless	0 - 31
FP_line	16 bit Integer	Fire pixel line	Sparse data array 1 – N	unitless	0 - 768
FP_sample	16 bit Integer	Fire pixel sample	Sparse data array 1 – N	unitless	0 – 3200
FP_latitude	32 bit Float	Fire pixel latitude	Sparse data array 1 – N	degrees	-90 - 90
FP_longitude	32 bit Float	Fire pixel longitude	Sparse data array 1 – N	degrees	-180 - 180
FP_power	32 bit Float	Fire radiative power	Sparse data array 1 – N	MW	0 - 5000
FP_confidence	8 bit Integer	Fire detection confidence	Sparse data array 1 – N	%	0 – 100
FP_land	8 bit Integer	Land pixel flag	Sparse data array 1 – N	unitless	1 – land 0 – water
18 FP diagnostic variables	See netCDF4 metadata	Variables to describe observing and environmental conditions, and results of algorithm tests	Sparse data array 1 – N	See netCDF4 metadata	See netCDF4 metadata
* N is a dimension of sparse data array; defined in “nfire” variable					

Table 1-4 Details of 2-dimenstional arrays within the NDEAF output file

Output	Type	Description	
Fire Mask	8-bit unsigned integer	Missing – 0	Missing input data
		Scan – 1	Not processed (obsolete)
		Other – 2	Not processed (obsolete)
		Water – 3	Pixel classified as non fire water
		Cloud – 4	Pixel classified as cloudy
		No Fire – 5	Pixel classified as non fire land
		Unknown – 6	Pixel with no valid background pixels
		Fire Low – 7	Fire pixel with confidence strictly less than 20% fire
		Fire Medium – 8	Fire pixel with confidence between 20% and 80%
		Fire High – 9	Fire pixel with confidence greater than or equal to 80%
Fire Algorithm QA Mask	32-bit unsigned integer	Details in Table 1-5	

Table 1-5 Details of the Quality Assessment (QA) mask within the NDEAF output file

Bits	Description

0-1	Surface Type (water=0, coastal=1, land=2)
2-3	Atmospheric correction
4	Day/Night (daytime = 1, nighttime = 0)
5	Potential fire (0/1)
6-10	Background window size parameter
11	Fire Test 1 valid (0 - No, 1 - Yes)
12	Fire Test 2 valid (0 - No, 1 - Yes)
13	Fire Test 3 valid (0 - No, 1 - Yes)
14	Fire Test 4 valid (0 - No, 1 - Yes)
15	Fire Test 5 valid (0 - No, 1 - Yes)
16	Fire Test 6 valid (0 - No, 1 - Yes)
17-19	N/A
20	Adjacent clouds (0/1)
21	Adjacent water (0/1)
22-23	Sun Glint Level (0-3)
24	Sun Glint rejection
25	False Alarm 1 (excessive rejection of legitimate background pixels)
26	False Alarm 2 (water pixel contamination)
27	Amazon forest-clearing rejection test
28-31	N/A

2. ALGORITHM

2.1. Algorithm Overview

The NDEAF product is generated using a hybrid thresholding- contextual algorithm for fire detection and a radiance method to calculate fire radiative power. The retrieval algorithm runs inside a system of supporting software. This system was originally developed during the NASA Earth Observing System mission to use data from the MODIS instrument. It was subsequently redesigned and tailored to process VIIRS data. The NDEAF retrieval algorithm has a flexible modular design that in principle enables it to process data from various instruments that provide compatible radiometric measurements necessary for the algorithm. For information about the NDEAF algorithm, see the NDE Active Fire Algorithm Theoretical Basis Document (NESDIS/STAR, 2015). The following sections describe the input files.

2.2. Input Satellite Data

2.2.1. Satellite Instruments

NDEAF is a system operated within the NDE DHS by OSPO. It uses data from the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (S-NPP) platform and on future satellites of the Joint Polar Satellite System (JPSS). S-NPP was launched on October 28, 2011. It is in a sun synchronous orbit with a 1:30pm ascending-node orbit at an altitude of 829 km.

The VIIRS instrument is a whiskbroom scanning radiometer with a swath width of 3060 km, providing full daily coverage both in the day and night side of the Earth. It has 22 spectral bands covering the spectrum between 0.412 μm and 12.01 μm, including 16 moderate resolution bands (M-bands) with a spatial resolution of 750 m at nadir, 5 imaging resolution bands (I-bands) – with a spatial resolution of 375 m at nadir, and one panchromatic DNB with a 750 m spatial resolution throughout the scan. Further details of the VIIRS sensor and the VIIRS SDR product can be found in the Visible Infrared Imaging Radiometer Suite (VIIRS) Sensor Data Record (SDR) User's Guide (NOAA Technical Report NESDIS 142A).

2.2.2. Satellite Data Preprocessing Overview

The VIIRS Raw Data Records (RDRs) are pre-processed into Sensor Data Records (SDRs) by the VIIRS SDR and VIIRS Geolocation algorithms. The preprocessing includes the geolocation and radiometric calibration of the raw sensor output. The NDEAF system uses the terrain-correct geolocation product. Details of the VIIRS SDR algorithm are described in the JPSS VIIRS Radiometric Calibration ATBD and the JPSS VIIRS Geolocation ATBD.

2.2.3. Input satellite data description

The NDEAF detection and FRP retrieval algorithms require radiometric measurements that provide quantitative information on the radiant output from hot spots and surrounding fire-free surfaces, as well as information on environmental and observing conditions necessary to eliminate potential false detection and identify exclusion zones (e.g. cloud obscuration, sun glint). The primary band for fire detection and characterization is the dual-gain M13 band that carries the radiative signal from hot spots. Table 2-1 provides a summary of the input VIIRS Sensor Data Record files used by the algorithm.

Table 2-1 Input VIIRS SDR data used by the NDEAF algorithm

Algorithm	Input to AF	Binary file	HDF5 file
VIIRS-SDR	latitude longitude view zenith angle solar zenith angle view azimuth angle solar azimuth angle	VIIRS-MOD-GEO-TC	GMTCO_*.h5
VIIRS-SDR	M13 brightness temperature M13 QF1 M13 radiance	VIIRS-M13-SDR	SVM13_*.h5
VIIRS-SDR	M15 scaled brightness temperature, QF1	VIIRS-M15-SDR	SVM15_*.h5
VIIRS-SDR	M16 scaled brightness temperature, QF1	VIIRS-M16-SDR	SVM16_*.h5
VIIRS-SDR	M5 scaled reflectance, QF1	VIIRS-M5-SDR	SVM5_*.h5
VIIRS-SDR	M7 scaled reflectance, QF1	VIIRS-M7-SDR	SVM7_*.h5
VIIRS-SDR	M11 scaled reflectance, QF1	VIIRS-11-SDR	SVM11_*.h5

2.3. Input Ancillary Data – The VIIRS Granulated Land/Water Mask

The VIIRS Granulated Land Water Mask product is produced by using VIIRS SDR Controller software employed in the Algorithm Development Library (ADL). While by default granulation is performed during SDR processing for all VIIRS channels, the VIIRS SDR Controller is configurable and granulation could be done as separate process. As an input, the granulation algorithm uses the Terrain Corrected Geolocation product which provides latitude and longitude at the geodetic center of the pixel. The granulation algorithm for land-water mask uses the Greatest Weight Neighbor (GWN) method. First, it calculates Area Weights (AW) and creates an intermediate product (AW-SWATH-Mod-IP). It contains a list of grid cells (up to a maximum) which contribute to the pixel. This list contains the grid cell's

row, column, tile ID, and weight (percentage of the grid cell that the pixel covers). Then the GWN selects the single greatest weighted match (according to the AW calculation). The AW intermediate product is used as an input for the Grid-To-Gran algorithm, along with the appropriate tiles from gridded product. The gridded tiles are derived from Quarterly Surface Type – Land Water Mask (QST-LWM) product - which consists of merged International Geosphere Biosphere Program (IGBP) QST product and MODIS Land Water Mask. QST-LWM augments the QST product by identifying coast and in- land water. The QST-LWM tiles are produced offline and stored in the system.

Ref: “Joint Polar Satellite System (JPSS) Operational Algorithm Description (OAD) Document for Gridding/Granulation (G/G) and VIIRS Gridded Intermediate Products (GIP) Software (474-00075)”

3. PERFORMANCE

3.1. Product Testing

3.1.1. Test Data

Description of all NDEAF test data (input, output) used in unit and system tests is provided in the NDE Active Fire Algorithm Readiness Review Report (NESDIS/STAR, 2015). This is available by contacting the NDE Active Fire Product Area Lead (PAL) at OSPO.

3.1.2. Test Plans

Description of all NDEAF test plans used in unit and system tests is provided in the NDE Active Fire Algorithm Readiness Review Report (NESDIS/STAR, 2015). These are available by contacting the NDE Active Fire Product Area Lead (PAL) at OSPO.

3.2. Product Accuracy

3.2.1. Test Results

Description of all NDEAF test results from the unit and system tests is provided in the NDE Active Fire Algorithm Readiness Review Document (NESDIS/STAR 2015). These are available by contacting the NDE Active Fire Product Area Lead (PAL) at OSPO.

3.2.2. Product Accuracy

Explicit validation of the accuracy of the product has not yet been conducted due to the lack of independent reference data. This work is scheduled to be completed during the Validation phase and will be performed after to the delivery of the operational code as part of the product maturity evaluation work. When this occurs, all testing documents will be updated and made available through the NDEAF PAL. However, product accuracy estimates can be made via theoretical calculations and via relating to the performance of the heritage MODIS product. These accuracy estimates are described in the NDE Active Fire Algorithm Theoretical Basis Document.

3.3. Product Quality

The various bits within the two-dimensional Quality Assessment (QA) array listed Table 1-5 describe various aspects of the observing and environmental conditions and the corresponding performance of the various steps if the active fire detection algorithm. The fire mask array variable shown in Table 1-4 also includes an indication of missing or non-processed data. Additionally, fire detections are provided based on their detection confidence value in the fire mask array variable (values 7 to 9). Further details on the QA bits and detection confidence are described in the NDE Active Fire Algorithm Theoretical Basis Document.

3.4. Analysis Tools

No external product tools are supplied. The NDEAF output files are netCDF4 files. External users can choose their own tools to display and analyze these output files.

4. PRODUCT STATUS

4.1. Operations Documentation

Operational logs contain the information regarding the changes made to science, instruments, and systems. Basically the Configuration Management system will have the detailed information about these changes, but operational logs keep the high level description of these changes.

NESDIS/STAR (2015), NDE Active Fire Algorithm Theoretical Basis Document, Version 1.0.

NESDIS/STAR (2015), NDE Active Fire System Maintenance Manual, Version 2.0.

NESDIS/STAR (2015), NDE Active Fire Algorithm Readiness Review Report (ARRR)

NDE Operations Handbook Version 1.0 (2013)

4.2. Maintenance History

The System Maintenance Manual (SMM) will be updated to reflect the changes that will be required to maintain the **NDE Active Fire** system within the ESPC environment. Information regarding the changes to the products is tracked by the Operational logs and will be available to users on request. Product metadata will be updated as per the changes required in the product including the version number, quality flags etc.

END OF DOCUMENT