Office of Satellite and Product Operations
Environmental Satellite Processing Center

NVPS Vegetation Index External Users' Manual

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Authors

John Lindeman (OCS)

Updated by Jeffrey Augenbaum (OMS, ERT)

Approval Page

Environmental Satellite Processing Center
NVPS Vegetation Index External Users' Manual

GROUP: OMS Date: 06/18/2024 Jeffrey Augenbaum, Lead Programmer	GROUP: OSPO Date: 06/25/2024 Hanjun Ding, Product Area Lead
GROUP: OMS Date: 07/08/2024 Clay Davenport, Products Manager	

Changes/Revisions Record

This external users' manual is changed as required to reflect system, operational, or organizational changes. Modifications made to this document are recorded in the Changes/Revisions Record below. This record will be maintained throughout the life of the document.

Version Number	Date	Description of Change/Revision	Section/Pages Affected	Changes Made by Name/Title/ Organization
4.1	01/2023	Original Version	All	Lindeman
4.2	05/2024	Updated for NCCF; Added links to product monitoring and visualization; Updated OSGS to OCS; Updated to latest document template	3.5; 3.5.1; All	Augenbaum
4.3	06/07/2024	Transfer contents to latest template, perform minor editing and formatting; For any section that did not include content in the previous version, the following note was inserted: "The original document did not include any content in this space."	All	Hannah Willett, Technical Writer, ERT Inc.
4.3		Quality Assurance	All	Clint Sherwood, Quality Assurance Manager, ERT Inc.

Preface

This document comprises the National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS), Office of Satellite and Product Operations (OSPO), publication of this NVPS Vegetation Index (VI) External Users' Manual. This document reflects current operations for the DOC/NOAA/NESDIS Environmental Satellite Processing Center (ESPC) (NOAA5045) information technology systems. This document describes the established ESPC procedures for external users of VI in accordance with Federal, DOC, NOAA, NESDIS and OSPO requirements.

Future updates and revisions to this document will be produced and controlled by DOC/NOAA/NESDIS for ESPC information technology systems.

The published version of this document can be found at the OSPO SharePoint Products Library.

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1. Products

This is an External Users' Manual (EUM) document describing the ~~NVPS (~~NDE Vegetation Products System (NVPS) ~~VI (~~Vegetation Index (VI) software package, which generates a consistent set of global and regional gridded vegetation products from ~~VIIRS (~~Visible Infrared Imaging Radiometer Suite (VIIRS) observations for initializing environmental models and monitoring land use and land cover change.

The intended users of the ~~External Users' Manual (~~EUM~~)~~ are end users of the output files and the product verification and validation (V&V) teams. The purpose of this document is to provide the document's users with information describing how to acquire the product, understand the product's features, and use any data associated with the products. External users are classified as those who do not have direct access to the processing system.

1.1. Product Overview

This document describes the NVPS VI system which generates the daily, weekly and bi-weekly global (0.036º) and regional (0.009º) gridded VI products and quality assurance (QA) flags with thematic information about the quality of the VI product. The main function of the VI system is to produce Top of Atmosphere (TOA) Normalized Difference Vegetation Index (NDVI), Top of Canopy (TOC) NDVI and Top of Canopy Enhanced Vegetation Index (TOC EVI) from the ~~Visible Infrared Imager Radiometer Suite (~~VIIRS~~)~~ sensor onboard Suomi National Polar-orbiting Partnership (SNPP) and NOAA20 satellites.

Error! Reference source not found. depicts an image of the global VI product at 0.036° resolution and whose horizontal dimensions are 10000 and 5000.

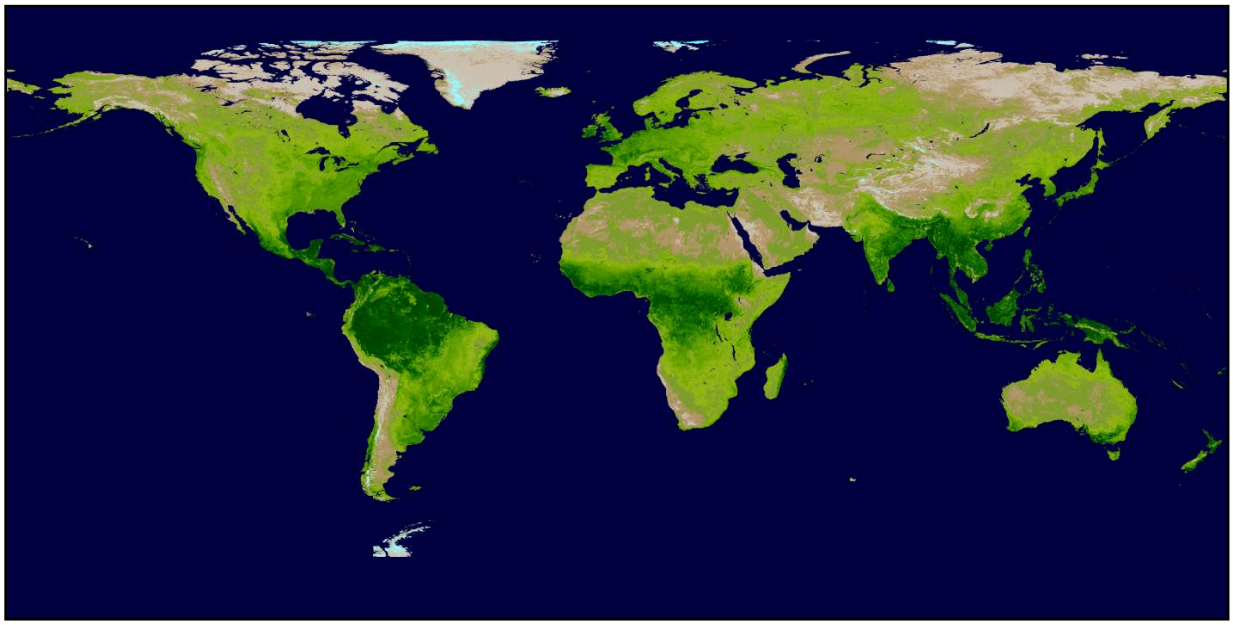

Figure 1-1 - Global VI Product Image

Note that this product system is one of two products for NVPS – the other being ~~GVF (~~Green Vegetation Fraction (GVF). Further information and references for GVF can be found in section **Error! Reference source not found.**.

The NVPS VI product system produces 30 products on a daily basis. Output files are generated in text, NetCDF and tif (image) formats.

1.1.1. Product Requirements

Running the NVPS VI package requires VIIRS visible imagery data, and VIIRS ~~AOD (~~Aerosol Optical Depth (AOD), Cloud Mask, and Surface Reflectance products. The products are generated separately with corresponding VIIRS satellite imagery data.

1.1.2. Product Team

The NVPS VI products development team consists of members from ~~OCS (~~Office of Common Services (OCS), ~~NESDIS (~~National Environmental Satellite, Data, and Information Service (NESDIS), ~~OSPO (~~Office of Satellite and Product Operations (OSPO), and ~~NWS (~~National Weather Service (NWS). The roles and contact information for the different product team members are identified in **Error! Reference source not found.**.

Table 1-1 - Product Team Members

Team Member	Organization	Role	Contact Information
Walter Wolf	OCS	Product Portfolio Management Lead	walter.wolf@noaa.gov
Kelly Neely	OCS	ASSISTT Project Manager	kelly.neely@noaa.gov
Shanna Sampson	OCS	ASSISTT Solutions Architect	shanna.sampson@noaa.gov
Priyanka Roy	OCS	ASSISTT	Priyanka.roy@noaa.gov
Gian Villamil-Otero	OCS	ASSISTT	gian.villamil-otero@noaa.gov
Yunhui Zhao	OCS	ASSISTT CM Lead & Special Projects	yunhui.zhao@noaa.gov
Yunyue (Bob) Yu	OCS	ASSISTT	
Zhangyan Jiang	OCS	ASSISTT	
Shukming (Eva) Wu	OCS	ASSISTT	
Ming Fang	OCS	ASSISTT	
Tracey Dorian	OCS	ASSISTT	
Letitia Soulliard	OCS	ASSISTT	
Hua Xie	OCS	ASSISTT Science QA	hua.xie@noaa.gov
Mingming Yao	OCS	ASSISTT	mingming.yao@noaa.gov
Edrees Wardak	OCS	ASSISTT	
Edward Borders	OCS	ASSISTT	edward.borders@noaa.gov
Jonathan Hansford	OCS	ASSISTT	
Ramaswamy Tiruchirapalli	OCS	ASSISTT	ramaswamy.tiruchirapalli@noaa.gov
John Lindeman	OCS	ASSISTT Documentation	john.lindeman@noaa.gov

PAL: Hanjun Ding

Email: Hanjun.Ding@noaa.gov

Feedback, comments, criticisms, suggestions, are welcome and should be sent to:

Kelly Neely

Email: Kelly.Neely@noaa.gov

Jonathan Hansford

Email: Jonathan.hansford@noaa.gov

Tracey Dorian

Email: Tracey.Dorian@noaa.gov

Priyanka Roy

Email: Priyanka.Roy@noaa.gov

Ramaswamy Tiruchirapalli

Email: Ramaswamy.Tiruchirapalli@noaa.gov

Edward Borders

Email: Edward.Borders@noaa.gov

1.1.3. Product Description

Current numerical weather prediction models and land surface monitoring systems require real time, large-scale land surface information for modeling initialization and monitoring land cover change. Daily global observations of the ~~Visible Infrared Imaging Radiometer Suite (~~VIIRS~~)~~ onboard ~~Joint Polar-orbiting Satellite System (~~JPSS~~)~~ are an excellent data source for such information. Thus, the NOAA JPSS Land Team has developed ~~a~~an NDE Vegetation Production System (NVPS) to produce ~~Vegetation Indices (~~VI~~)~~ and ~~Green Vegetation Fraction (~~GVF~~)~~. The VIs include ~~Normalized Difference Vegetation Index (~~NDVI~~)~~ at ~~Top Of Atmosphere (~~TOA~~)~~ and at ~~Top Of Canopy (~~TOC~~)~~, and TOC ~~Enhanced Vegetation Index (~~EVI~~)~~. These VI data are produced at three temporal resolutions (daily, 8-day rolling, and 16-day rolling intervals), and at two spatial scales (globally at 0.036°and regionally at 0.009°). The GVF data are produced at daily rolling 7-day intervals and at the same global and regional scales as VI.

The NVPS will continue to generate the operational VIIRS Green Vegetation Fraction (GVF) products as well as the gridded VIIRS ~~vegetation indices (~~VI~~)~~. The VIIRS vegetation indices generated by the NVPS are the ~~Top of the Atmosphere (~~TOA~~)~~ ~~Normalized Difference Vegetation Index (~~NDVI~~)~~, the ~~Top of the Canopy (~~TOC~~)~~ NDVI, and the TOC ~~Enhanced Vegetation Index (~~EVI~~)~~. All the NVPS products are derived from reflectance data from the ~~Visible Infrared Imager Radiometer Suite (~~VIIRS~~)~~ sensor onboard the Suomi National Polar-orbiting Partnership (S-NPP), NOAA-20, or other satellites, for applications in numerical weather and seasonal climate prediction models at the National Centers for Environmental Prediction (NCEP). The NVPS retrieval algorithm uses TOA VIIRS red (I1), TOA VIIRS near-infrared (I2) reflectance bands, as well as TOC VIIRS red (I1), TOC VIIRS near-infrared (I2), and TOC VIIRS blue (M3) surface reflectance bands to calculate the TOA NDVI, TOC NDVI and TOC EVI. The three vegetation indices are produced daily, weekly and bi-weekly at 4-km resolution (global scale) and 1-km resolution (regional scale). GVF is derived from TOC EVI and is generated on a daily rolling weekly basis. The weekly and bi-weekly composited VI products are generated every day.

Table 1-2 - NVPS Vegetation Index Products

Product Category	Algorithm	Products
NDE Vegetation Products System (NVPS)	Vegetation Index (VI) subsystem	• NetCDF, Geotiff, and text output files containing all the derived variables of the VI product

1.2. Product History

The OCS ~~(Office of Common Services) ASSISTT (~~Algorithm Scientific Software Integration and System Transition Team (ASSISTT) group produces meteorological products designed for operational use. ASSISTT transitions meteorological product algorithms created by science/academic research teams into products for use and disseminated by NOAA operations.

NVPS VI is an upgrade to the S-NPP VIIRS GVF system that has been running operationally at NDE since February 2015. The S-NPP VIIRS GVF software system has been enhanced to generate along with the GVF products a gridded version (globally and regionally) of the VIIRS ~~Vegetation Index (~~VI~~)~~ EDR products.

1.3. Product Access

The 30 products created on a daily basis from the NVPS VI product system are in text, NetCDF and tif (image) formats. The filenames are shown in **Error! Reference source not found.**. Each of the ten rows represents three files for daily, weekly, and bi-weekly temporal resolutions of the product.

Table 1-3 - NVPS VI Product Output Files

File	Description	Format	Size/file
VI-[DLY,WKL,BWKL]-REG _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 or 16]_c[YYYYMMDDhhmmsss].nc	This is the daily, weekly or biweekly regional VI product	netCDF4	Typical file size 1.6 GB.
VI-[DLY,WKL,BWKL]-GLB _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 OR 16]_c[YYYYMMDDhhmmsss].nc	This is the daily, weekly or biweekly global VI product	netCDF4	Typical file size 245 MB.
VI-TOA-NDVI-[DLY,WKL,BWKL]-REG _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 OR 16]_c[YYYYMMDDhhmmsss].tif	Browse image of the TOA NDVI daily, weekly, or biweekly regional VI product	Geotiff	Typical file size 45 MB
VI-TOA-NDVI-[DLY,WKL,BWKL]-GLB _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 OR 16]_c[YYYYMMDDhhmmsss].tif	Browse image of the TOA NDVI daily, weekly or biweekly global VI product	Geotiff	Typical file size 7 MB
VI-TOC-NDVI-[DLY,WKL,BWKL]-REG _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 OR 16]_c[YYYYMMDDhhmmsss].tif	Browse image of the TOC NDVI daily, weekly or biweekly regional VI product	Geotiff	Typical file size 45 MB
VI-TOC-NDVI-[DLY,WKL,BWKL]-GLB _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 OR 16]_c[YYYYMMDDhhmmsss].tif	Browse image of the TOC NDVI daily, weekly or biweekly global VI product	Geotiff	Typical file size 7 MB

File	Description	Format	Size/file
VI-TOC-EVI-[DLY,WKL,BWKL]-REG _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 OR 16]_c[YYYYMMDDhhmmsss].tif	Browse image of the TOC EVI daily, weekly or biweekly regional VI product	Geotiff	Typical file size 45 MB
VI-TOC-EVI-[DLY,WKL,BWKL]-GLB _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 OR 16]_c[YYYYMMDDhhmmsss].tif	Browse image of the TOC EVI daily, weekly or biweekly global VI product	Geotiff	Typical file size 7 MB
VI-[DLY,WKL,BWKL]-REG _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 OR 16]_c[YYYYMMDDhhmmsss]_stat.txt	Statistics file of the daily, weekly or biweekly regional VI product for monitoring purposes	text	Typical file size 4 KB
VI-[DLY,WKL,BWKL]-GLB _vxry_sid_s[YYYYMMDD1]_e[YYYYMMDD1,7 or 16]_c[YYYYMMDDhhmmsss]_stat.txt	Statistics file of the daily, weekly or biweekly global VI product for monitoring purposes	text	Typical file size 4 KB

Descriptions of the lettering used in the output filenames are listed in **Error! Reference source not found.**

Table 1-4 - NVPS VI Output Files Standard Name Description

Sequence	Description
GVF	Green Vegetation Fraction
VI	Vegetation Indices (NDVI, EVI)
NDVI	Normal Difference Vegetation Index
EVI	Enhanced Vegetation Index
DLY	Daily (1-day temporal scale)
WKL	Weekly (8-day temporal resolution)
BWKL	Biweekly (16-day temporal resolution, in term of conventions)
GLB	Global (spatial resolution: 4-km)
REG	Regional (spatial resolution:1-km)
TOA	Top of Atmosphere
TOC	Top of Canopy
vxry	Version (e.g., v2r2)
sid	Indicates the observations from JPSS-01
s	start (data observation time)
e	end (data observation time)
c	current (data processing time)
YYYYMMDD	4-digit year, 2-digit month, and 2-digit day
hhmmsss	2-digit hour, 2-digit minute, 2-digit second, and 1-digit fractional second
.nc	netCDF4 file

.tif	GeoTiff image file
stat.txt	Text file stored statistics analysis results

Examples of the 30 output filenames for an NVPS VI run are:

VI-TOA-NDVI-WKL-GLB_v2r1_j01_s20200409_e20200416_c202301040528020.tif VI-TOC-NDVI-WKL-REG_v2r1_j01_s20200409_e20200416_c202301040529050.tif

VI-TOA-NDVI-WKL-REG_v2r1_j01_s20200409_e20200416_c202301040529050.tif VI-WKL-GLB_v2r1_j01_s20200409_e20200416_c202301040528020.nc

VI-TOC-EVI-WKL-GLB_v2r1_j01_s20200409_e20200416_c202301040528020.tif VI-WKL-GLB_v2r1_j01_s20200409_e20200416_c202301040528020_stat.txt

VI-TOC-EVI-WKL-REG_v2r1_j01_s20200409_e20200416_c202301040529050.tif VI-WKL-REG_v2r1_j01_s20200409_e20200416_c202301040529050.nc

VI-TOC-NDVI-WKL-GLB_v2r1_j01_s20200409_e20200416_c202301040528020.tif VI-WKL-REG_v2r1_j01_s20200409_e20200416_c202301040529050_stat.txt

VI-BWKL-GLB_v2r1_j01_s20200401_e20200416_c202301040541030.nc VI-TOA-NDVI-BWKL-REG_v2r1_j01_s20200401_e20200416_c202301040542070.tif

VI-BWKL-GLB_v2r1_j01_s20200401_e20200416_c202301040541030_stat.txt VI-TOC-EVI-BWKL-GLB_v2r1_j01_s20200401_e20200416_c202301040541030.tif

VI-BWKL-REG_v2r1_j01_s20200401_e20200416_c202301040542070.nc VI-TOC-EVI-BWKL-REG_v2r1_j01_s20200401_e20200416_c202301040542070.tif

VI-BWKL-REG_v2r1_j01_s20200401_e20200416_c202301040542070_stat.txt VI-TOC-NDVI-BWKL-GLB_v2r1_j01_s20200401_e20200416_c202301040541030.tif

VI-TOA-NDVI-BWKL-GLB_v2r1_j01_s20200401_e20200416_c202301040541030.tif VI-TOC-NDVI-BWKL-REG_v2r1_j01_s20200401_e20200416_c202301040542070.tif

VI-DLY-GLB_v2r1_j01_s20200416_e20200416_c202301040509250.nc VI-TOA-NDVI-DLY-REG_v2r1_j01_s20200416_e20200416_c202301040510260.tif

VI-DLY-GLB_v2r1_j01_s20200416_e20200416_c202301040509250_stat.txt VI-TOC-EVI-DLY-GLB_v2r1_j01_s20200416_e20200416_c202301040509250.tif

VI-DLY-REG_v2r1_j01_s20200416_e20200416_c202301040510260.nc VI-TOC-EVI-DLY-REG_v2r1_j01_s20200416_e20200416_c202301040510260.tif

VI-DLY-REG_v2r1_j01_s20200416_e20200416_c202301040510260_stat.txt VI-TOC-NDVI-DLY-GLB_v2r1_j01_s20200416_e20200416_c202301040509250.tif

VI-TOA-NDVI-DLY-GLB_v2r1_j01_s20200416_e20200416_c202301040509250.tif VI-TOC-NDVI-DLY-REG_v2r1_j01_s20200416_e20200416_c202301040510260.tif

The VI product includes the following data fields:

1) Three VI Products: NDVI_TOA, EVI_TOC and NDVI_TOC;
2) Five aggregated reflectance bands: I1_TOA, I2_TOA, I1_TOC,I2_TOC, and M3_TOC
3) Geometry Information: RAA: Relative Azimuth Angle, SZA: Solar Zenith Angle, and VZA: Viewing Zenith Angle;
4) Two Quality Flags (QFs).
5) Geospatial Coordinates: latitude, longitude

The descriptions of these data fields are listed in **Error! Reference source not found.**.

Table 1-5 - Data Fields of the NVPS VI Products

Data Name	Data Description	Data Type	Dimension	Units	Data Range
EVI_TOC	Top of Canopy Enhanced Vegetation Index	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	n/a	[-1,1]
I1_TOA	Top of Atmosphere Reflectance band	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	n/a	[0,1]
I1_TOC	Top of Canopy Reflectance band	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	n/a	[0,1]
I2_TOA	Top of Atmosphere Reflectance band	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	n/a	[0,1]
I2_TOC	Top of Canopy Reflectance band	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	n/a	[0,1]
M3_TOC	Top of Canopy Reflectance band	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	n/a	[0,1]
NDVI_TOA	Top of Atmosphere Normalized Difference Vegetation Index	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	n/a	[-1,1]
NDVI_TOC	Top of Canopy Normalized Difference Vegetation Index	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	n/a	[-1,1]
QF1	Quality Flag Byte 0 (See Table 3-5)	8-bit unsigned character	5000x10000 (Global) 10384x28889 (Regional)	n/a	[0, 255]

Data Name	Data Description	Data Type	Dimension	Units	Data Range
QF2	Quality Flag Byte 1 (See Table 3-5)	8-bit unsigned character	5000x10000 (Global) 10384x28889 (Regional)	n/a	[0, 255]
RAA	Relative Azimuth Angle	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	deg	[-180,180]
SZA	Solar Zenith Angle	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	deg	[0,90]
VZA	Viewing Zenith Angle	16-bit Integer	5000x10000 (Global) 10384x28889 (Regional)	deg	[0,90]
Latitude	Geospatial coordinate	32-bit float	5000x1 (Global) 10384x1 (Regional)	deg	[-90º,90º] [-7.5º,90º]
Longitude	Geospatial coordinate	32-bit float	10000x1 (Global) 28889x1 (Regional)	deg	[-180º,180º] [-230º,30º]
plate_carree*	Plate Carree projection corner lats/lons and resolution*	short	0	see attribute desc*	lat: [-90, 90] lon: [-180,180]
quality_information_EVI_TOC**	product quality information for EVI_TOC**	string	0	see attribute desc**	n/a
quality_information_NDVI_TOA***	product quality information for NDVI_TOA***	string	0	see attribute desc***	n/a
quality_information_NDVI_TOC****	product quality information for NDVI_TOC****	string	0	see attribute desc****	n/a

* plate_carree values are located in variable attributes = [geospatial_lat_max, geospatial_lat_min, geospatial_lat_resolution, geospatial_lat_units, geospatial_lon_max, geospatial_lon_min, geospatial_lon_resolution, geospatial_lon_units, grid_mapping_name, latitude_of_projection_origin, longitude_of_central_meridian, standard_parallel_1]
** quality_information_EVI_TOC values are located in variable attributes = [total number of retrievals, percentage_optimal_retrievals, percentage of suboptimal retrievals, percentage of bad retrievals, total_number_unprocessed]
*** quality_information_NDVI_TOA values are located in variable attributes = [total number of retrievals, percentage_optimal_retrievals, percentage of suboptimal retrievals, percentage of bad retrievals, total_number_unprocessed]
**** quality_information_NDVI_TOC values are located in variable attributes = [total number of retrievals, percentage_optimal_retrievals, percentage of suboptimal retrievals, percentage of bad retrievals, total_number_unprocessed]

There are two quality flags in the NVPS VI output files, listed as QF1 and QF2. More information about these fields can be found in section **Error! Reference source not found.**.

Metadata contained in the NetCDF files is listed in **Error! Reference source not found.**.

Table 1-6 - NVPS VI Metadata

Attribute	Description	Type	Array Size
_NCProperties	NetCDF and HDF version numbers, will be automatically generated	String	Scalar
cdm_data_type	States the geographic category the product represents	String	Scalar
creator_email	Email for the algorithm development team	String	Scalar
creator_name	Indicates the line office and algorithm team responsible for product development	String	Scalar
creator_url	The url address for the algorithm team responsible for product development	String	Scalar
date_created	UTC time the product file was created in 4-digit year, 2-digit month, 2-digit day, 2-digit hour, 2-digit minute, 2-digit second format	String	Scalar
geospatial_lat_max	Maximum latitude within the geospatial bounds	Float	Scalar
geospatial_lat_min	Minimum latitude within the geospatial bounds	Float	Scalar
geospatial_lat_resolution	The latitudinal resolution	Float	Scalar
geospatial_lat_units	Indicates unit associated with geospatial latitude	String	Scalar
geospatial_lon_max	Maximum longitude within the geospatial bounds	Float	Scalar
geospatial_lon_min	Minimum longitude within the geospatial bounds	Float	Scalar
geospatial_lon_resolution	The longitudinal resolution	Float	Scalar
geospatial_lon_units	Indicates unit associated with geospatial longitude	String	Scalar
history	Indicates algorithm name and version responsible for creating the file	String	Scalar
id	Unique identifier for the product	String	Scalar
institution	Indicates institution responsible for product file	String	Scalar
instrument	Name of the relevant satellite instrument	String	Scalar
keywords	Searchable words or phrases associated with this product	String	1
metadata_link	Contains a URL where detailed metadata or a product information page is located	String	Scalar
naming_authority	Organization responsible for providing the "id" attribute	String	Scalar
platform	Satellite platform (name) associated with this product	String	Scalar
processing_level	Level of processing associated with product file	String	Scalar
production_environment	Processing string responsible for generating the product	String	Scalar
production_site	Processing site for the product	String	Scalar
project	Indicates the name(s) of the project(s) responsible for generating the original data used as input to the processing system	String	Scalar
publisher_email	Provides an email that can be used to contact the person or entity who is responsible for publishing the output files to the proper end users	String	Scalar
publisher_name	Provides the name of the organization responsible for the product's publication	String	Scalar
publisher_url	Provides URL of publisher's website	String	Scalar
source	Provides a list of all significant input files into the product system as a comma separated list	String	Scalar

Attribute	Description	Type	Array Size
standard_name_vocabulary	Provides the name and corresponding version number of the controlled vocabulary used	String	Scalar
summary	Provides a brief summary of the product	String	Scalar
time_coverage_end	Indicates the end time of the observation associated with the file in 4-digit year, 2-digit month, 2-digit day, 2-digit hour, 2-digit minute, 2-digit second format	String	Scalar
time_coverage_start	Indicates the start time of the observation associated with the file in 4-digit year, 2-digit month, 2-digit day, 2-digit hour, 2-digit minute, 2-digit second format	String	Scalar
title	Provides the short name for the product	String	Scalar

2. Algorithm

2.1. Algorithm Overview

NVPS VI produces the following VI products: TOA NDVI, TOC NDVI and TOC EVI. The VI products will be generated at three different temporal resolutions: daily, weekly (8-day) and bi-weekly (16-day) and at two spatial resolutions: global (0.036° = 4-km) and regional (0.009° =1-km). The VI composited products (weekly and bi-weekly) are generated every day. All VI products are derived from NOAA-20 VIIRS granule data. The final VI data product files include a 0.009° (1-km) VI regional file, and a 0.036° (4-km) global file, both in NetCDF4 format. Five major steps are required to generate the VI products:

Step 1: Gridding: VIIRS swath TOA reflectance in bands I1 and I2, and TOC surface reflectance data in bands I1, I2, and M3 during a calendar day (0000 – 2400 UTC) are mapped to the native VI geographic grid (0.003 degree Plate Carrée projection) to produce gridded daily TOA reflectance and surface reflectance maps, respectively. Assurance (QA) information, including land cover types, cloud confidences, aerosol optical thickness, and band data availabilities, is also determined at the 0.003 degree scale. If more than one pixel maps to the same 0.003 degree grid cell on the same day, one of those pixels is selected through a compositing process to be retained and the others are discarded.

Step 2: Reflectance aggregation: The daily gridded reflectance TOA and TOC reflectance data at the 0.003° grid are aggregated 3x3 to a 0.009° grid (~ 1 km) based on the spatial average method. The daily gridded TOA and TOC reflectance at the 0.003° grid are also aggregated 12x12 to a 0.036° grid (~ 4 km) based on the spatial average method. Not all pixels in the 3x3 or 12x12 aggregation areas are included in the average. The pixels to be included in the aggregation are determined as described in the quality flag processing section below.

Step 3: VI calculation: TOA NDVI is calculated using the aggregated TOA reflectance and TOC NDVI and EVI are calculated using the aggregated TOC reflectance at 1-km and 4-km resolutions respectively. The results of the daily reflectance aggregation and VI calculations are written out into netCDF format intermediate files in blocks in order to facilitate parallel processing of the downstream 8- and 16- day products. The intermediate block data and quality flag fields are identical to the output data and quality flag fields except for field dimensions. The aggregated reflectance and calculated VI are also geographically mosaicked

to produce the full global and regional vegetation index, reflectance, quality assurance, and sun/ view angles, which are written out in netCDF format as the daily global and regional VI EDRs

Step 4: Compositing: The VI algorithm input includes the VIIRS TOA and TOC reflectance and geolocation data for each granule. Daily VI are computed from daily aggregated TOA and TOC reflectances. Daily vegetation index data in an 8-day period are composited daily (daily rolling weekly). Eight-day vegetation index data are composited every day to produce a daily rolling biweekly (16 day) VI product. A daily rolling 8- or 16-day compositing period can start at any day of a year and covers 8 or 16 days. The next compositing period shifts one day after the last 8-day or 16-day period. At the end of a year, a compositing period covers some days in the next year if there are not enough days left in the year. The end result of composting over an 8-day or 16-day period is a single file containing, for each 0.009 or 0.036 degree grid point, TOA NDVI, TOC NDVI, TOC EVI, TOA and TOC red (I1) and NIR (I2) reflectance, TOC blue (M3) reflectance, sensor and solar zenith angles, relative azimuth angle, and quality flags in a netCDF file.

Step 5: VI QA assignment: The daily gridded TOA and TOC reflectances and the derived VI products are subject to impact of environmental factors including cloud, aerosol and sun glint. Hence the quality assurances of derived VI products on the aggregated pixels are based on the cloud mask, quality flags in VIIRS Surface Reflectance data files, Aerosol Optical Thickness data files at granule level and the spatial aggregation scheme.

For detailed information about the VI algorithm, see the JPSS VIIRS Vegetation Index Algorithm Theoretical Basis Document (https://www.star.nesdis.noaa.gov/jpss/documents/ATBD/D0001-M01-S01-025_JPSS_ATBD_VIIRS-Vegetation-Index_A.pdf).

2.1.1. Pre-Processing Steps

Pre-processing is not required for NVPS VI.

2.2. Input Satellite Data

2.2.1. Satellite Instrument Overview

The JRR NVPS VI processing system uses VIIRS data to create the expected output files. This data includes the VIIRS Science Data Records (SDR) High Resolution Bands (SVI) and the Terrain Corrected Geolocation data GITCO. See section **Error! Reference source not found.** for more information on the VIIRS data.

2.2.2. Satellite Data Preprocessing Overview

There are no pre-processing steps performed on the input satellite data for the NVPS VI Products algorithm package.

2.2.3. Input Satellite Data Description

The NVPS VI processing system ingests the following I-Band channels: GITCO and SVI bands 1 and 2.

Table 2-1 - NDVI VI Product Input Satellite Data

Input Data Products	Description	Format	Source
GITCO	Geolocation	H5	IDPS
SVI01	TOA Reflectance at 640 nm	H5	IDPS
SVI02	TOA Reflectance at 865 nm	H5	IDPS

Additionally, externally-generated JPSS Risk Reduction products are required to produce the NVPS VI products. Specifically, these products include the Surface Reflectance, Cloud Mask, and Aerosol Optical Depth. The filenames for these products are in the following format:

JRR-<algorithm>_<version>_<sat>_s<YYYYmmddHHMMSSs>_e<YYYYmmddHHMMSSs>
_c<YYYYmmddHHMMSSs>.nc

Where:

<algorithm> - Either JRR-AOD, JRR-CloudMask, or SurfRefl

<version> -JPSSRR version. The current version is v2r1.

<sat> - Satellite, either npp, j01, or n21

s<YYYYmmddHHMMSSs> - Start date and time of the granule to the nearest tenth of a second

e<YYYYmmddHHMMSSs> - End date and time of the granule to the nearest tenth of a second

c<YYYYmmddHHMMSSs> - Creation date and time of the file to the nearest tenth of a second

2.3. Ancillary Data Files

Two optional Intermediate Products data files can be used as inputs of a VI process on a particular process date if they are available. They are:

- VI-DLY IP files from DAILY_OUTBLOCK
- VI-WKL IP files from WEEKLY_OUTBLOCK respectively.

Error! Reference source not found. contains information about the optional ancillary data files.

Table 2-2 - Optional Intermediate Products from Previous VI Run

Types	Sample filename
VI-DLY-<GLB/REG> *DAILY_OUTBLOCK in PCF	VI-DLY-GLB_v2r1_j01_s$_e$_c&_h??v??.nc VI-DLY-REG_v2r1_j01_s$_e$_c&_h??v??.nc *$ = yyyymmdd, &=yyyymmddhhmmsst* *(h?? in horizontal range of [00, 03], v?? in vertical range of [00, 01])*
VI-WKL-<GLB/REG> *WEEKLY_OUTBLOCK in PCF	VI-WKL-GLB_v2r1_j01_s$_e$_c&_h??v??.nc VI-WKL-REG_v2r1_j01_s$_e$_c&_h??v??.nc *$ = yyyymmdd, &=yyyymmddhhmmsst* *(h?? in horizontal range of [00, 03], v?? in vertical range of [00, 01])*

2.3.1. Static Ancillary Data

Static ancillary data files are included in the package delivered to operations.

2.3.2. Other Required Inputs

Two configuration YAML files are used in the NVPS VI products processing system: one responsible for launching the Docker container and another responsible for running the NVPS VI processing package.

3. Performance

3.1. Product Testing

3.1.1. Test Data Description

Test cases will be provided with each delivery of the processing package to ensure product verification can occur before the system becomes operational. Each test case will provide the necessary input data files, and their corresponding output data files. Once end users of the products are satisfied that all requirements have been sufficiently met, the products will be transitioned into operations.

3.1.2. Unit Test Plans

Testing of all products produced by the processing package will occur with each software update. The Office of Common Services (OCS) is responsible for testing each algorithm and script to ensure all requirements are met. Before each product becomes operational, the products must be tested to ensure they run successfully on the intended system. If there are any issues that arise during testing procedures, all relevant groups must work together to "iron-out" these issues.

3.2. Product Accuracy

3.2.1. Test Results

See section **Error! Reference source not found.**.

3.2.2. Product Accuracy

3.3. Product Quality

The details of the bit layout of the VI quality flags are listed in **Error! Reference source not found.**. There are two QF bytes in the NVPS VI output files, listed as QF1 and QF2. These fields are bit-mapped quality fields for the inputs and outputs of the algorithm.

Table 3-1 - Bit Layout of the Two QF bytes in NVPS VI Product

Byte	VIIRS VI Flag	Result	Bits
QF1	Overall TOA NDVI Quality	0000 = Excellent 1000 = Snow/Ice 0001 = Good 1001 = Cloud 0010 = Acceptable 1010 = Estimated (CMG) 0011 = Marginal 1011 = No Data 0100 = Pass 1111 = Water/Ocean 0101 = Questionable 0110 = Poor 0111 =Cloud Shadow (Refer to Figure 9 for a flowchart of how these values are determined.)	4(bits 0-3)
	Overall TOC NDVI Quality	0000 = Excellent 1000 = Snow/Ice 0001 = Good 1001 = Cloud 0010 = Acceptable 1010 = Estimated (CMG) 0011 = Marginal 1011 = NO Data 0100 = Pass 1111 = Water/Ocean 0101 = Questionable 0110 = Poor 0111 =Cloud Shadow (Refer to Figure 9 for a flowchart of how these values are determined.)	4 (bits 4-7
QF2	EVI or EVI2	0 = EVI 1 = EVI2	1 (bit 0)
	Land Cover Type	00 = Snow/Ice 01 = Land 10 = Water/Ocean 11 = Desert	2 (bits 1-2)
	Cloud Confidence	00 = Confidently Clear 01 = Probably Clear 10 = Probably Cloudy 11 = Confidently Cloudy	2 (bits 3-4)
	Aerosol Quantity	00 = Climatology 01 = Low 10 = Average 11 = High	2 (bits 5-6)
	Cloud Shadow	0 = No Shadow 1 = Shadow	1 (bit 7)

3.4. External Product Tools

No external product tools are provided.

3.5. Output Files

NVPS VI final products are available on PDA for user subscription. The data retention time on PDA is the standard 7 days.

3.5.1. Product Monitoring and Visualization

Product quality is monitored using the NCCF Product Monitoring Tool at https://nccf.espc.nesdis.noaa.gov/mtool/index.html.

Users can use this page to monitor hourly summaries of the NVPS VI quality based on parameter thresholds determined by the PAL.

The NCCF Products Visualization Page at https://www.ospo.noaa.gov/products/land/vi/ can also be used to view global images of select parameters in near real-time. These images are updated daily.

4. Product Status

4.1. Operations Documentation

Vargas, M., Miura, T., Shabanov, N., & Kato, A. (2013). An initial assessment of Suomi NPP VIIRS vegetation index EDR. Journal of Geophysical Research-Atmospheres, 118, 12301-12316.

NESDIS/STAR (2021): Vegetation Index (VI) Product Algorithm Theoretical Basis Document (ATBD) v2.1

NESDIS/STAR (2021): Green Vegetation Fraction (GVF) Product Algorithm Theoretical Basis Document (ATBD) v4.1

NESDIS/STAR (2022): NDE Vegetation Products System (NVPS) External Users' Manual (EUM) v2.2

NESDIS/STAR (2022): NDE Vegetation Products System (NVPS) System Maintenance Manual (SMM) v2.2

NESDIS/STAR (2022): NVPS VI Product Delivery memo, Readme file, PCF_PSF doc, and Production Rules doc

NESDIS/STAR (2022): Normalized Vegetation Products System (NVPS) Green Vegetation Fraction (GVF) System Maintenance Manual

NESDIS/STAR (2022): Normalized Vegetation Products System (NVPS) Green Vegetation Fraction (GVF) External Users' Manual

NESDIS/STAR (2022): Normalized Vegetation Products System (NVPS) Vegetation Index (VI) System Maintenance Manual

4.2. Maintenance History

5. Acronyms

Acronym	Definition
ASSISTT	Algorithm Scientific Software Integration and System Transition Team
CM	Configuration Management
EUM	External Users' Manual
EVI	Enhanced Vegetation Index
GVF	Green Vegetation Fraction
IP	Intermediate Product
JPSS	Joint Polar Satellite System
NCEP	National Centers for Environmental Prediction
NDE	NPP Data Exploitation
NDVI	Normalized Vegetation Index
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
NUP	NOAA-Unique Product
NVPS	NDE Vegetation Products System
NWS	National Weather Service
OCS	Office of Common Services
OSPO	Office of Satellite and Product Operations
PAL	Product Area Lead
PDA	Product Data Assimilation
QA	Quality Assurance
SNPP	Suomi National Polar-orbiting Partnership
TOA	Top of the Atmosphere
TOC	Top of Canopy
V&V	Verification and Validation
VI	Vegetation Index
VIIRS	Visible Infrared Imaging Radiometer Suite