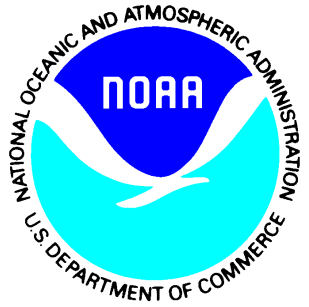
NOAA NESDIS
CENTER FOR SATELLITE APPLICATIONS AND RESEARCH

The NVPS Vegetation Index System Maintenance Manual (SMM)



Version 4.2,
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TITLE: THE NVPS VEGETATION INDEX SYSTEM MAINTENANCE MANUAL
VERSION 4.2

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APPROVAL SIGNATURES:

Jan 2023

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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.

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DOCUMENT CHANGE HISTORY			
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4.1	January 2023	Created by John Lindeman	
4.2	May 2024	OSPO	

LIST OF CHANGES

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

DOCUMENT TITLE: The NVPS Vegetation Index System Maintenance Manual					
LIST OF CHANGE-AFFECTED PAGES/SECTIONS/APPENDICES					
Version Number	**Date**	**Changed By**	**Page**	**Section**	**Description of Change(s)**
4.1	Jan 2023	Lindeman	All	All	Original Version
4.2	May 2024	Augenbaum			Updated by Jeffrey Augenbaum
				2.1/2.2	Added links to NCCF SMM
				5.3	Added links to Product monitoring, visualization and Alarms
				7.1	Added data flow diagrams
				1.3,2.1,2.2,4.2.2,4.2.3,4.4.1,5.2-5.3, 6.1-6.3	Added links to NCCF SMM

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LIST OF ACRONYMS

ACSPO	Advanced Clear Sky Processor for Ocean
AHI	Advanced Himawari Imager
ASSISTT	Algorithm Scientific Software Integration and System Transition Team
CCAP	Cloud Containerized Algorithm Package
CPU	Central Processing Unit
DDS	Data Distribution Server
ESPC	Earth System Prediction Capability
EUM	External Users Manual
GB	Gigabyte
GVF	Green Vegetation Fraction
NCCF	NESDIS Cloud Common Framework
NCEI	National Centers for Environmental Information
NDE	NPOESS Data Exploitation
NESDIS	National Environmental Satellite, Data, and Information Service
NetCDF	Network Common Data Format version
NetCDF4	Network Common Data Format version 4
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-Orbiting Operational Environmental Satellite System
NVPS	NDE Vegetation Product System
NWP	Numerical Weather Prediction
NWS	National Weather Service

OCS	Office of Common Services
OSPO	Office of Satellite and Product Operations
PAL	Product Area Lead
PCF	Process Control File
PDA	Product Distribution and Access
PSF	Process Status File
QC	Quality Control
SMM	System Maintenance Manual
SST	Sea Surface Temperature
STAR	Center for Satellite Applications and Research
v#r#	version<number>release<number>
VI	Vegetation Index

EXECUTIVE SUMMARY

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

The NVPS VI package was designed to run within the NCCF (NESDIS Cloud Common Framework) production environment.

The product development team consists of members from OCS (Office of Common Services), NESDIS (National Environmental Satellite, Data, and Information Service), OSPO (Office of Satellite and Product Operations), and NWS (National Weather Service). The team member's name, organization, role, and contact information can be seen in Table 0-1.

Table 0-1 - Product Team Members

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Shukming (Eva) Wu	OCS	ASSISTT	
Ming Fang	OCS	ASSISTT	
Tracey Dorian	OCS	ASSISTT	
Letitia Soulliard	OCS	ASSISTT	
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The low-level code within the NVPS VI processing system is written in Fortran 90 and C++. This low-level code performs all data processing, scientific computation, reading/writing, reformatting, and opening/closing of files. All high-level code within the NVPS VI processing system is written in Python. The high-level code performs tasks such as file management, system management, making system calls, and error trapping from the lower-level processing. The driver script will manage the NVPS VI software and call any necessary unit scripts. The system is comprised of only one unit that handles all of the NVPS VI processing. This unit will, therefore, produce all expected output product files.

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 (Earth System Prediction Capability) data products and later by the Product Distribution and Access (PDA) system.

The output products are intended for operational and scientific users. Table 0-2 provides information about the algorithms and products.

Table 0-2 – 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. INTRODUCTION

1.1. Product Overview

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 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.

1.2. Algorithm Overview

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).

1.3. Interfaces Overview

Before reviewing this System Maintenance Manual (SMM), please request the live **master NCCF SMM** (refer to ***System Maintenance Manual - NESDIS Common Cloud Framework (NCCF)***) from the OSPO PALs in Table 1-2. The NCCF system overview is described in the **master NCCF SMM: NCCF Description and Overview (or Document Object: 4,5).**

2. HARDWARE

2.1. Hardware Description

The hardware is described in the **master NCCF SMM: NCCF Description and Overview (or Document Object: 4,5): Infrastructure**.

2.2. Operating System

The NCCF operating system description can be found in the **master NCCF SMM: Operating System (or Document Object: 64).**

2.3. System Requirements

The system requirements and timing information for each product are listed below:

System Requirements:

Memory	16GB (4GB per CPU/core)
CPU	4

Timing Information:

Processing Unit	User Time (seconds)	Elapsed Time (mm:ss)
VI	10900	180:27

2.3.1. Storage Requirements

The amount of required storage will depend on the number of files being processed. Each execution of NVPS VI produces 30 output files which are distributed into three subdirectories of 10 files each. The biweekly_aasr subdirectory requires about 1.7GB of storage space, daily_aasr ~ 1.6GB, and weekly_aasr ~1.7GB. Log files are less than 1MB in size.

The intermediate files are placed into 4 subdirectories for NVPS VI. The biweekly_outBlock subdirectory requires about 1.5GB of storage space, daily_outBlock ~ 1.4GB, daily_sr ~ 25GB, and weekly_outBlock ~ 1.5GB.

The delivery tar gzip files are as follows: 76MB for CODE, 218GB for DATA, and several MB for DOCS.

2.3.2. Computer Resource Requirements

The required libraries and utilities will be included in the Docker container.

2.3.3. Communication Needs

The target system for the NVPS VI package is the NESDIS Common Cloud Framework (NCCF). There are no special bandwidth or communication issues associated with NVPS VI. The communication needs of the processing system must be sufficient to meet the processing requirements described throughout this document.

3. SOFTWARE

This section describes the system-level software elements that are invoked by the OSPO production system. Next, this section describes the source code and system files delivered to OSPO. These files are organized into subdirectories. The contents of each subdirectory are identified and their purpose is explained.

3.1. Software Description

The NVPS VI software mainly consists of C++ program files, and yaml and python scripts. These files and scripts are listed below, along with the subdirectory in which they are contained. A description of the directory structure can be found in section 3.2.

aggRefl/
aggRefl_main.cpp
BlockWaterMask.cpp
error.cpp
nc4SR.cpp
nvpsclimat.cpp
NVPSUtil.cpp
QA.cpp
SR.cpp
WaterMask.cpp

common/
AllGranule.cpp
AOT.cpp
BlockWaterMask.cpp
error.cpp
EVI.cpp
GeoLoc.cpp
nc4series.cpp
nc4SR.cpp
nvpsclimat.cpp
NVPSUtil.cpp
Refl1.cpp
Refl2.cpp
SR.cpp
SRTile.cpp
SurfRefl.cpp
Test_IsTOI_main.cpp
VI.cpp
WaterMask.cpp

DailyGrid/
AllGranule.cpp
AOT.cpp

DailyGrid_main.cpp
error.cpp
GeoLoc.cpp
NVPSUtil.cpp
Refl1.cpp
Refl2.cpp
SRTile.cpp
SurfRefl.cpp
WaterMask.cpp

GranuleOnTile/
AllGranule.cpp
error.cpp
GeoLoc.cpp
GranuleIndex.cpp
GranuleOnTile_main.cpp
NVPSUtil.cpp

Mosaic/
error.cpp
mosaic_main.cpp
nc4SR.cpp
NVPSUtil.cpp

Multilevel_waterMask/
BlockWaterMask.cpp
error.cpp
gen_subTile_waterMask_main.cpp
NVPSUtil.cpp
test_water_mask.cpp
WaterMask.cpp

WeeklyComposite/
error.cpp
nc4SR.cpp
NVPSUtil.cpp
WeeklyComposite_main.cpp

config_files/VI/
application_info.yaml
docker_info.yaml

3.2. Directory Description

The NVPS VI CCAP delivery consists of 3 gzip'd tar files:

- NVPS_VI_CODE_202212.tar.gz
- NVPS_VI_DOCS_202212.tar.gz
- NVPS_VI_DATA_202212.tar.gz

Once unpacked, there will be four subdirectories immediately following the parent directory:

- wrapper - contains the science code
- nvps - contains ancillary data for VI algorithm and a sample test case
- DATA - contains python scripts and configuration files to launch and run the docker
- DOCS - contains the documentation for this CCAP

Using $base to denote the parent directory, the subdirectories are organized as thus:

```
$base/
        wrapper/
                config_files/VI/
                dockerfiles/VI/
                        scripts/
                                ccap_utils/
                                common_utils/
                                utils/
        nvps/
                build/
                        build_scripts/
                /VI_CODE_NDE/
                        code/
                        compile/
                        EXEDIR/
                        run/
                        code/
                                aggRefl/
                                common/
                                DailyGrid/
                                GranuleOnTile/
                                Mosaic/
                                Multilevel_waterMask/
```

WeeklyComposite/
DATA/
nvpsclimat/
watermask/

Here is the Docker Information:

1. Packages/Libraries installed in the docker image
    a. python 3.9.16
        i. Jinja2==3.1.2
        ii. PyYAML==6.0

2. Docker Image information
    a. Base Image: centos:7
    b. Image Size: 596 MB
    c. Repository Name: 754153872510.dkr.ecr.us-east-1.amazonaws.com/assistt-centos7-python3-nvps-vi
    d. Tag Name: v1.0

3.3. Source Code Description

The source code, written in C++, carries out the NVPS VI algorithm steps as described in section 1.2.

4. NORMAL OPERATIONS

4.1. System Control

Several yaml and python scripts are responsible for the execution of NVPS VI. The scripts begin the process by setting up the parameters, deciding what gets processed, and running the algorithm.

4.1.1. System Control Files

The wrapper scripts and configuration files are described below:

docker_info.yaml – Contains information for setting up the docker run command. For convenience, all the items which may vary between runs or which are system specific are located at the top of the YAML as anchors in arguments.

application_info.yaml – Guides the inner script, namely which satellite and time should be processed. It also contains other inputs required by the VI algorithm.

nvps_vi.py – The inner driver of the CCAP wrapper. This executes the VI algorithm to generate the desired outputs. This script uses the "*gen_viirs_vi_template.sh"* script to generate the PCF required by the algorithm.

gen_viirs_vi_template.sh - Bash script that creates the PCF required for the VI algorithm.

launch.py – Starts the docker container and runs the nvps_vi script to process the data pointed to by the application_info and docker_info configuration files.

4.1.2. Processing Controls

The docker_info and application_info yaml files require a series of arguments to successfully execute. Here's a list of these arguments, and then examples of the yaml files follows:

- `&wrapper_dir`
  - Path to directory
    - contains python wrapper scripts
- `&application_yaml`
  - Path to file
    - application YAML file for the run.
- `&log_dir`
  - Path to directory
    - directory where logs should be exported.
- `&sat`
  - The satellite this job is processing
    - Used only to name the Docker container
- `&caseid`
  - Case ID for run.
    - Used only to name the Docker container
    - eg. d20200401

- `&bash_dir`
  - Path to directory
    - should point to the "run" directory of VI algorithm. `$root/nvps/VI_CODE_NDE/run`
- `&exec_dir`
  - Path to directory
    - should point to the "EXEDIR" directory of VI algorithm. `$root/nvps/VI_CODE_NDE/EXEDIR`
- `&gitco_granule_dir`
  - Path to directory
    - contains all `GITCO` input granules for a given run
- `&aod_granule_dir`
  - Path to directory
    - contains all `JRR-AOD` input granules for a given run
- `&cloud_mask_granule_dir`
  - Path to directory
    - contains all `JRR-CloudMask` input granules for a given run
- `&sr_granule_dir`
  - Path to directory
    - contains all `SR` input granules for a given run
- `&svi01_granule_dir`
  - Path to directory
    - contains all `SVI01` input granules for a given run
- `&svi02_granule_dir`
  - Path to directory
    - contains all `SVI02` input granules for a given run
- `&climate_dir`
  - Path to directory
    - contains the climatological static ancillary data `$root/DATA/nvpsclimat`
- `&watermask_dir`
  - Path to directory
    - contains the `watermask` static ancillary data `$root/DATA/watermask`
- `&biweekly_aasr`
  - Path to directory
    - contains the VI "biweekly" `aasr` input output files. The output files will be under the "<start_date>-<end_date>" sub-directory.
- `&biweekly_outBlock`

    - Path to directory
        - contains the VI "biweekly" `OUTBLOCK` input and output files. The files should/will be under the "<start_date>-<end_date>" sub-directory.
- `&weekly_aasr`
    - Path to directory
        - contains the "weekly" `aasr` output files. The output files will be under the "<start_date>-<end_date>" sub-directory.
- `&weekly_outBlock`
    - Path to directory
        - contains the "weekly" `OUTBLOCK` input and output files. The files should/will be under the "<start_date>-<end_date>" sub-directory.
- `&daily_aasr`
    - Path to directory
        - contains the "daily" `aasr` output files. The output files will be under the "YYYYmmdd" sub-directory.
- `&daily_outBlock`
    - Path to directory
        - contains the "daily" `OUTBLOCK` input and output files. The files should/will be under the "YYYYmmdd" sub-directory.
- `&daily_sr`
    - Path to directory
        - contains the daily-sr output files. The output files will be under the "YYYYmmdd" sub-directory.

where

- ➔ "YYYYmmdd" represents the date corresponding to `job_coverage_start` anchor in application_info.yaml file. example 20200401
- ➔ <end_date> represents the data ending date in "YYYYmmdd" format. corresponding to `job_coverage_start` anchor in application_info.yaml file in "YYYYmmdd" format. example 20200401
- ➔ <start_date> represents the data starting date in "YYYYmmdd" format. For bi-weekly, the date is **16 days** before <end_date>. For weekly, the date is **8 days** before <end_date>. For `20200401` run, the <start_date> for weekly would be `20200325` and for bi-weekly would be `20200317`

docker_info.yaml

arguments:

- &gitco_granule_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_input/input/GITCO
- &aod_granule_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_input/input/JRR-AOD
- &cloud_mask_granule_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_input/input/JRR-CloudMask
- &sr_granule_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_input/input/SR
- &svi01_granule_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_input/input/SVI01
- &svi02_granule_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_input/input/SVI02
- &wrapper_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/wrapper
- &bash_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/nvps/VI_C
ODE_NDE/run

- &climate_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/nvps
climat
-
&watermask_dir /share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_2
02212/DATA/watermask
- &exec_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/nvps/VI_C
ODE_NDE/EXEDIR
- &biweekly_aasr
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_results/output/biweekly_aasr
- &biweekly_outBlock
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_results/intermediate/biweekly_outBlock
- &weekly_aasr
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_results/output/weekly_aasr
- &weekly_outBlock
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_results/intermediate/weekly_outBlock

```
  - &daily_aasr
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_results/output/daily_aasr
  - &daily_outBlock
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_results/intermediate/daily_outBlock
  - &daily_sr
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_results/intermediate/daily_sr

  - &log_dir
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/DATA/sam
ple_results/logs
  - &application_yaml
/share/data/assistt/jonathan.hansford/NVPS/NVPS_VI_Final_CCAP_202212/wrapper/co
nfig_files/VI/application_info.yaml
  - &sat J01
  - &caseid "20220416"
  - &memory 16Gb

docker_info:
  image: 754153872510.dkr.ecr.us-east-1.amazonaws.com/assistt-centos7-python3-
nvps-vi:v1.0
  python_info:
    python: python3
    script: /home/WORKING_DIR/wrapper/scripts/nvps_vi.py
    application_yaml: /home/WORKING_DIR/CONFIG/application_info.yaml

  mount_pairs:
    - src: *wrapper_dir
      dst: /home/WORKING_DIR/wrapper

    - src: *log_dir
      dst: /home/WORKING_DIR/logs

    - src: *application_yaml
      dst: /home/WORKING_DIR/CONFIG/application_info.yaml

    - src: *bash_dir
      dst: /home/WORKING_DIR/run

    - src: *climate_dir
      dst: /home/WORKING_DIR/nvpsclimat

    - src: *watermask_dir
```

```
  dst: /home/WORKING_DIR/watermask

- src: *exec_dir
  dst: /home/WORKING_DIR/EXEDIR

- src: *gitco_granule_dir
  dst: /home/WORKING_DIR/input/GITCO

- src: *aod_granule_dir
  dst: /home/WORKING_DIR/input/JRR-AOD

- src: *sr_granule_dir
  dst: /home/WORKING_DIR/input/SR

- src: *cloud_mask_granule_dir
  dst: /home/WORKING_DIR/input/JRR-CloudMask

- src: *svi01_granule_dir
  dst: /home/WORKING_DIR/input/SVI01

- src: *svi02_granule_dir
  dst: /home/WORKING_DIR/input/SVI02

- src: *biweekly_aasr
  dst: /home/WORKING_DIR/output/biweekly_aasr

- src: *weekly_aasr
  dst: /home/WORKING_DIR/output/weekly_aasr

- src: *daily_aasr
  dst: /home/WORKING_DIR/output/daily_aasr

- src: *biweekly_outBlock
  dst: /home/WORKING_DIR/output/biweekly_outBlock

- src: *weekly_outBlock
  dst: /home/WORKING_DIR/output/weekly_outBlock

- src: *daily_outBlock
  dst: /home/WORKING_DIR/output/daily_outBlock

- src: *daily_sr
  dst: /home/WORKING_DIR/output/daily_sr
```

```
  docker_args:
    memory: *memory
    ulimit:
      stack: -1
  container_name:
    sat: *sat
    proj: NVPS_VI
    caseid: *caseid
```

application_info.yaml

```
arguments:
  - &job_coverage_start 20200416
  - &sat "J01"
  # default value for n_proc is "4"
  - &n_proc "4"
  - &PRODUCTION_SITE "STAR PPM"
  - &PRODUCTION_ENVIRONMENT "DEV"

application_info:
  outdir:
    - name: biweekly_aasr
      path: /home/WORKING_DIR/output/biweekly_aasr
    - name: biweekly_outBlock
      path: /home/WORKING_DIR/output/biweekly_outBlock
    - name: weekly_aasr
      path: /home/WORKING_DIR/output/weekly_aasr
    - name: weekly_outBlock
      path: /home/WORKING_DIR/output/weekly_outBlock
    - name: daily_aasr
      path: /home/WORKING_DIR/output/daily_aasr
    - name: daily_outBlock
      path: /home/WORKING_DIR/output/daily_outBlock
    - name: daily_sr
      path: /home/WORKING_DIR/output/daily_sr
  logdir: /home/WORKING_DIR/logs

  algorithm_spec:
    - name: SATELLITE_NAME
      value: *sat
    - name: start_time
      value: *job_coverage_start
    - name: VI_PROC_PER_JOB
      value: *n_proc
```

```
- name: PRODUCTION_SITE
  value: *PRODUCTION_SITE
- name: PRODUCTION_ENVIRONMENT
  value: *PRODUCTION_ENVIRONMENT

- name: input_dir
  value: /home/WORKING_DIR/input
- name: work_dir
  value: /home/WORKING_DIR/work_dir
- name: VI_WORKING_DIRECTORY
  value: /home/WORKING_DIR/work_dir
- name: template_script
  value: /home/WORKING_DIR/wrapper/scripts/gen_viirs_vi_template.sh
- name: log_dir
  value: /home/WORKING_DIR/logs
- name: GRANULE_DIRECTORY
  value: /home/WORKING_DIR/work_dir
- name: VI_BASH_DIRECTORY
  value: /home/WORKING_DIR/run
- name: CLIMATE_DIRECTORY
  value: /home/WORKING_DIR/nvpsclimat
- name: WATERMASK_DIRECTORY
  value: /home/WORKING_DIR/watermask
- name: VI_EXECUTION_DIRECTORY
  value: /home/WORKING_DIR/EXEDIR
```

4.2. Installation

4.2.1. Installation Items

For more information concerning the installation items created after unpacking the NVPS VI delivery package, please refer to section 3.2.

4.2.2. Compilation Procedures

See the **master NCCF SMM: Compilation Procedures and Build Procedures (or Document Object: 76,78)**

4.2.3. Installation Procedures

4.3. Configuration Procedures

See the **master NCCF SMM: Compilation Procedures and Build Procedures (or Document Object: 76,78)**

4.3.1. Production Rules

Please see the Production Rules document provided with this CCAP delivery.

4.4. Operations Procedures

4.4.1. Normal Operations

Please refer to the master NCCF SMM:Procedures for Normal Operations (or Document Object 10)

4.5. Distribution

4.5.1. Data Transfer / Communications

Please refer to the master NCCF SMM: Data Transfer/Communications and Data Preparation (or Document Object 73, 81)

4.5.2. Distribution Restrictions

There are no restrictions on NVPS_VI product distribution

4.5.3. Product Retention Requirements

4.5.4. External Product Tools

External software is not provided for viewing/analyzing NVPS VI.

5. MONITORING AND MAINTENANCE

5.1. Job Monitoring

The operational system and the NVPS VI algorithm log files produced with the execution can be used to monitor the jobs.

5.1.1 **Product Monitoring Visualization and Alarms**

Product quality is monitored using the NCCF Product Monitoring Tool https://nccf.espc.nesdis.noaa.gov/mtool/index.html
. Users can use this page to monitor hourly summaries of the NVPS VI product quality based on parameter thresholds determined by the PAL.
The NCCF NVPS VI product webpage at

https://www.ospo.noaa.gov/Products/land/vi/

can also be used to view cloud composite images of select parameters in near real-time. These images are updated daily.

NCCF PG Product Latency and Product Missing Alarms can be found at https://us-east-1.console.aws.amazon.com/cloudwatch/home?region=us-east-1#alarmsV2

5.2. Data Signal Monitoring

5.3. Product Monitoring

In addition to the log files, quality flags, variables, and metadata information can be used to evaluate the NVPS VI products.

5.3.1. Unit Test Plans

5.3.2. Internal Product Tools

5.3.3. Performance Statistics

5.3.4. Product Monitoring

5.3.5. Product Criticality

5.4. Maintenance

5.4.1. Monitoring

See the **master NCCF SMM: Maintenance Utilities (or Document Object: 84)**

5.4.1.1. Ingest Monitoring

See the **master NCCF SMM: Data Transfer/Communications and Data Preparation (or Document Object: 73 and 81)**

5.4.1.2. Production Job Monitoring

5.4.1.3. Product Distribution Monitoring

5.4.2. Science Maintenance

Product quality monitoring is performed by the OSPO Product Quality Monitoring System and the OCS developers. OCS and OSPO personnel communicate regularly to discuss any potential data quality issues, formulate updates to the code, and schedule updates to the package's science code.

5.4.3. Library Maintenance

See the **master NCCF SMM:Library Maintenance (or Document Object: 71)**

5.4.4. Special Maintenance Procedures

See the **master NCCF SMM: Special Maintenance Procedures (or Document Object: 72)**

5.4.5. Maintenance Utilities

See the **master NCCF SMM: Maintenance Utilities (or Document Object: 84)**

5.5. Program Backup Procedures

See the **master NCCF SMM:Data Recovery Procedures and Program Recovery Procedures (or Document Object: 89, 90)**

6. TROUBLESHOOTING

6.1. Problem Diagnosis and Recovery

See the **master NCCF SMM: Problem Diagnosis and Recovery Procedures (or Document Object: 82)**

6.1.1. Quality Control Output

6.1.2. Error Correction

See the **master NCCF SMM: Error Correction – Warnings and Messages for Systems and Error Codes, Menus and Navigation (or Document Object: 43,44,45)**

6.1.3. Problem Diagnosis and Recovery Procedures

See the **master NCCF SMM:Problem Diagnosis and Recovery Procedures (or Document Object: 82)**

6.1.3.1. High-Level Errors

6.1.3.2. Low-Level Errors

6.1.4. Data Recovery Procedures

See the **master NCCF SMM: Data Recovery Procedures (or Document Object: 89)**

6.1.5. Program Recovery Procedures

6.2. Application Shutdown and Restart

See the **master NCCF SMM: Program Recovery Procedures (or Document Object: 90)**

6.2.1. Application Shutdown Procedures

See the **master NCCF SMM: Application Shutdown Procedures (or Document Object: 94)**

6.2.2. Application Restart Procedures

See the **master NCCF SMM: Application Restart Procedures (or Document Object: 92)**

6.3. System Shutdown and Restart

See the **master NCCF SMM: Reboot Procedures, Restart Procedures and Shutdown Procedures (or Document Object: 83, 93, 95)**

6.3.1. System Shutdown Procedures

6.3.2. System Restart Procedures

6.3.3. System Reboot Procedures

7. APPENDIX 1 – DATA DESCRIPTION

7.1. Data Flow

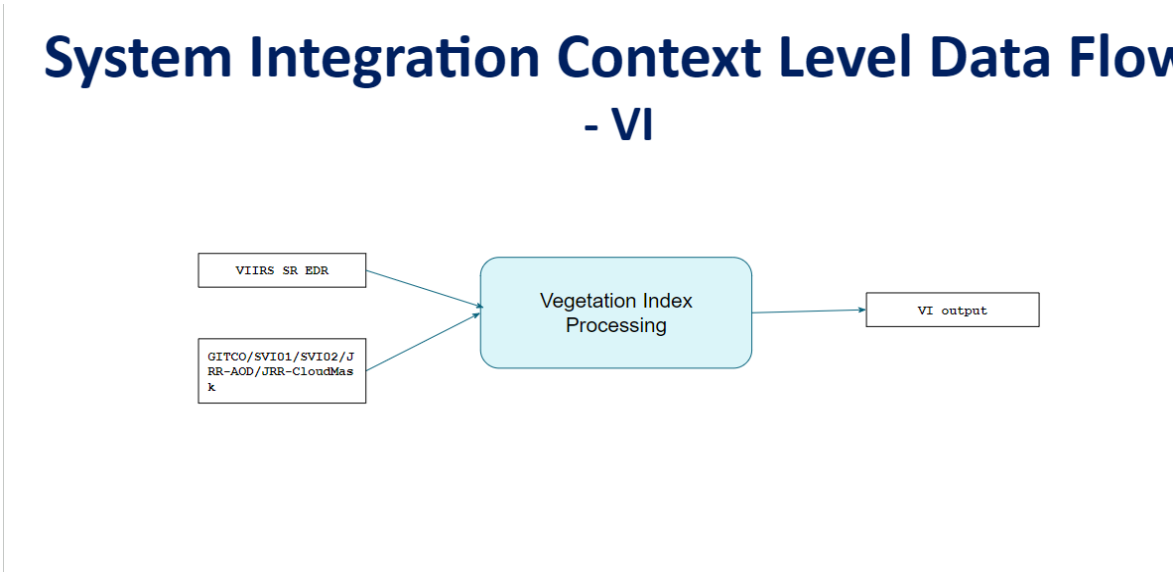

Figure 7-1 – Context Level Data Flow

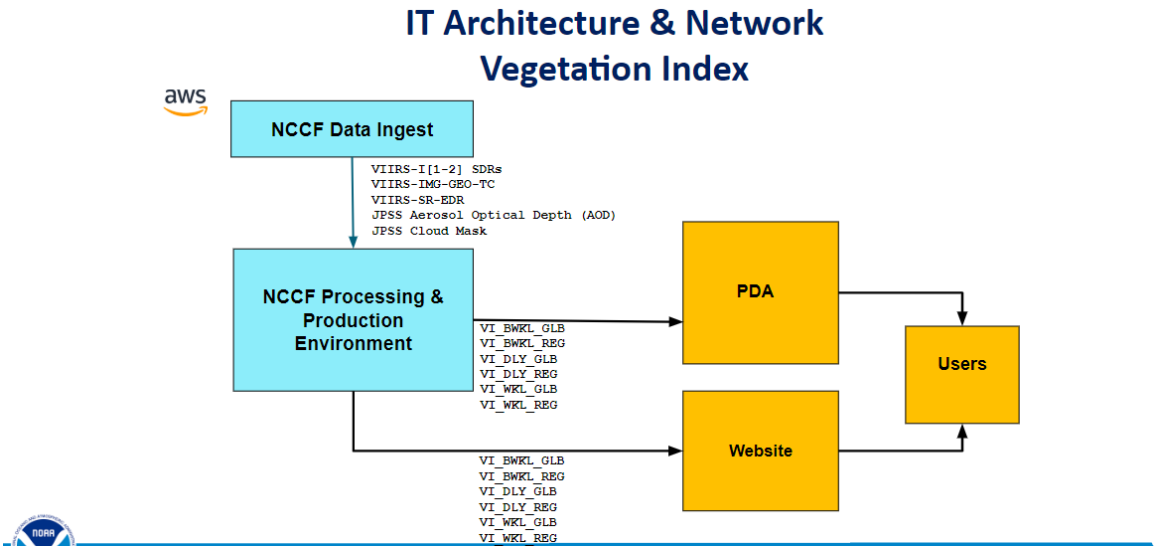

Figure 7-2 – IT Architecture & Network

7.2. Input Data Files

The NVPS VI processing system ingests the following I-Band channels: GITCO and SVI bands 1 and 2, as shown in Table 7-1.

Table 7-1 - 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

7.3. 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.

Table 7-2 contains information about the optional ancillary data files.

Table 7-2 - 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])*

7.4. Look Up Tables

Static ancillary data files are included in the package delivered to operations. Climatological data and the watermask are needed to generate the NVPS VI products.

7.5. Intermediate Data Set Description

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

7.6. Output Data Set Description

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 Table 7-3. Each of the ten rows represents three files for daily, weekly, and bi-weekly temporal resolutions of the product.

Table 7-3 - 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	netCDF 4	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	netCDF 4	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
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 Table 7-4

Table 7-4 - 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

7.7. Archive Data Files

The NetCDF output files for NVPS VI will be archived at NCEI.

7.8. References

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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) External Users Manual