VIIRS- Vegetation Health Product (VIIRS-VH)

External Users Manual

Compiled by
VIIRS- VH Development Team

Version 1.2
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TITLE: VIIRS-VH EXTERNAL USERS MANUAL VERSION 1.2

AUTHORS:

Felix Kogan (STAR)

Wei Guo(IMSG)

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: VIIRS-VH External Users Manual			
DOCUMENT CHANGE HISTORY			
Revision No.	**Date**	**Revision Originator Project Group**	**CCR Approval # and Date**
1.0	8/15/2014	initial version by STAR developer	
1.1	4/30/2015	STAR developer	
1.2	6/15/2015	STAR developer	

LIST OF CHANGES

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

DOCUMENT TITLE: VIIRS-VH External Users Manual					
LIST OF CHANGE-AFFECTED PAGES/SECTIONS/APPENDICES					
Version Number	**Date**	**Changed By**	**Page**	**Section**	**Description of Change(s)**
1.2	6/15/2015	STAR developer			File name convention

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1. PRODUCTS

1.1. Product Overview

1.1.1. Product Requirements

State the requirements for each product, either explicitly or by reference to the project's requirements document, if available. Product requirements should include content, format, latency, quality. *(Document Object 1)*[1]
Writers: Development Lead.

- VHP Products include:
- Vegetation Condition Index (VCI)
- Temperature Condition Index (TCI)
- Vegetation Health Index (VHI)
- VHP Products measurement range: 0-100%
- VHP Products accuracy: <4%
- Quality information: Added
- Validation & verification: Added
- Generate NetCDF4 files
- Flag anomalous values
- Generate imagery

1.1.2. Product Team

State the product team members (development, help desk and operations), roles, and contact information. Generic contacts - PAL, development lead, help desk. *(Document Object 2)*
Writers: Development Lead and PAL should collaborate

- NDE will provide the system monitoring capability
- OSPO PAL will perform product quality monitoring as part of the Product Monitoring project.
- OSPO PAL and STAR Scientists will perform routine validation of the VHP products

Contacts:

- Felix Kogan (STAR) – Lead, Development Readiness and Quality Control support
- Wei Guo (STAR) – Development support

[1] If Document Objects have been written, the indicated object should be directly inserted to satisfy each template instruction. Document Objects are described in the External Users Manual Standards and Guidelines http://projects.osd.noaa.gov/spsrb/standards_data_mtg.htm

- Hanjun Ding (OSPO) – Operational Readiness and Quality control support
- Yufeng Zhu(OSPO) – Operational Maintenance support
- NDE Personnel
- Donna McNamara (OSPO) – Distribution Lead
- Jing Han (OSPO) NDE Lead

1.1.3. Product Description

Product description with sufficient detail so that the user understands how to use the product files. *(Document Object 34)*
Writers: Algorithm Scientists

VIIRS-VH product is gridded weekly global vegetation indices (Vegetation Condition Index (VCI), Temperature Condition Index (TCI) and Vegetation Health Index (VHI)) derived from VIIRS Scientific Data Records (SDR) for the global area between latitude 55°S to 75°N. The projection of VHP product is Plate Carree projection (geographic projection, a grid with equal latitude-longitude interval). The interval of grid is 0.036° degree (about 4km at equator). Noise is minimized by applying the time series smoothing technique and other correction algorithms.

1.2. Product History

State the major product development steps and milestones, with links to relevant project artifacts. *(Document Object 3)*
Writers: Development Lead

VIIRS-VH was developed from the proto-type product AVHRR-VHP which is gridded weekly global vegetation indices (VCI,TCI and VHI) derived from NOAA satellites (NOAA 7,9,11,14,16,18,19). AVHRR-VHP was an operational product at NESDIS OSPO since 2012. VIIRS-VH also uses the climatology derived from AVHRR-VHP dataset.

1.3. Product Access

Provide information that each user needs to obtain the data products intended for them. This includes the location of the data products and procedures for obtaining them. State the organizations and personnel who ensure maintenance and access. *(Document Object 36)*
Writers: PAL

User will obtain archived VIIRS-VH product from CLASS system.

State the procedures that should be followed for obtaining near real time (NRT) and archived product data files. This information may be in the developer's Operations Concept

Document (OCD). Refer to the OCD in the developer's project artifact repository, if available. *(Document Object 46)*
Writers: PAL

An Archive Product will be produced for the CLASS archive. The Archive Product will be the output netCDF4 files that are produced by the VIIRS-VH weekly production run. User will obtain the product from CLASS system.

List each output file that is produced during a processing run. For each output data file, provide details on data format/type, range of values and special error values at a level of detail that is sufficient for the operator or user to verify that the required output data files are produced correctly. Include data volume and file size. Include all information needed to verify that the required output data is created by a run; i.e. to verify that all expected datasets are produced in the expected format. This information may be in the developer's Detailed Design Document (DDD). Refer to the DDD in the developer's project artifact repository, if available. *(Document Object 51)*
Writers: Development Programmers.

VIIRS VH system produces Vegetation Health (VH) product weekly. The major output variables are Vegetation Condition index (VCI), Thermal Condition Index (TCI) and Vegetation Health Index (VHI). File format is NETCDF. For 4km product, each file is about 30 MB. The following end products are distributed to users:

VCI/TCI/VHI retrievals and quality control flags stored in NetCDF format:
GVH4kmFinalVH_npp_s201401010000000_e2014010723599_c201402260101000.nc
GVH4kmInitialVH_npp_s201402190000000_e2014022523599_c201402260101000.nc

Noise removed NDVI and BT:
GVH4kmFinalSM_npp_s201401010000000_e2014010723599_c201402260101000.nc
GVH4kmInitialSM_npp_s201402190000000_e2014022523599_c201402260101000.nc

Because VIIRS-VH uses (15 weeks) time series smoothing technique, the data in the middle of the time series presents the best result. In real time operation mode, the latest week's result is called "initial product", and the data of 7th weeks ago is called "final product".

The following Scientific Data Sets (SDS) are included in these NETCDF file.

File type	SDS name	SDS type	content	range	Scale_factor
SM	SMN	Int16	Smoothed NDVI (noise removed NDVI)	[-0.1,1]	0.001
	SMT	Int16	Smoothed BT (noise removed BT)	[0,400]	0.1
	QA	Int8	Quality Flag		
VH	VCI	Int16	Vegetation Condition index	[0,100]	0.01
	TCI	Int16	Thermal Condition Index	[0,100]	0.01

	VHI	Int16	Vegetation Health Index	[0,100]	0.01
	QA	Int8	Quality Flag		

Scientific Data Sets (SDS) with data type “Int16” are scaled from floating number to 2-bytes integers by the following equation:

science_data = packed_data * scale_factor + add_offset

In both SM and VH file, “add_offset” are always 0 for all SDS with “int16” data type.

List each output file that will be sent to the archive. Provide details on data format/type at a level of detail that is sufficient for the operator to verify that the archive files are produced correctly. This information will be in the Submission Agreement (SA) and may be in the developer’s Detailed Design Document (DDD). Refer to the SA. Refer to the DDD in the developer’s project artifact repository, if available. *(Document Object 37)*
Writers: PALs and Development Programmers should collaborate.

VIIRS VH system produces Vegetation Health (VH) product weekly. The major output variables are Vegetation Condition index (VCI), Thermal Condition Index (TCI) and Vegetation Health Index (VHI). The following end products are required to archive:

4 files are required to archive: The final (7^{th} weeks ago) and initial (the current week) noise removed NDVI and BT (SM file) and vegetation health product (VH) file.

For example, on Feb 26 2014, the following files will be created for archive:
GVH4kmFinalSM_npp_s201401010000000_e2014010723599_c201402260101000.nc
GVH4kmFinalVH_npp_s201401010000000_e2014010723599_c201402260101000.nc
GVH4kmInitialSM_npp_s201402190000000_e2014022523599_c201402260101000.nc
GVH4kmInitialVH_npp_s201402190000000_e2014022523599_c201402260101000.nc

(See previous section from detail on data format)

Note the contents of any collection level and granule level metadata provided to the archives per the Submission Agreement (SA) by the algorithm. This information should adhere to the NESDIS Data Center's best practice for metadata, specifically the ISO 19115-2 standards for Geographic information. Metadata content is worked in coordination with SA and the Data Center representative. Refer to the SA and coordinating guidance from the SPSRB *(Document Object 96)*
Writers: Development Lead and PAL should collaborate.

Metadata will be saved in both NETCDF file (as file attributes) and XML file with same file name but extension. Below are example contents of VH metadata stored in NETCDF file GVH4kmFinalVH_npp_s201503050000000_e201503112359599_c201505061620363.nc.

```
GVH4kmFinalVH_npp_s201503050000000_e201503112359599_c201505061620363.nc (0)
   Group size = 6
   Number of attributes = 40
      ANCILLARY_FILES =
File_Configure=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/control/VHconfig.viirs_weekly_4
km
File_PCF=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/ViirsVH_weekly.pcf
File_Metadata_Regions=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/ancillary/regions_for_m
etadata.txt
File_IGBPLandTypes=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/ancillary/gigbp2_landtype
_11.hdf
File_Static_Metadata=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/ancillary/vgvi_static_meta
data.txt
DIR_ND=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/VH
DIR_SM=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/VH
DIR_VH=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/VH
DIR_PartialDailyMap=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/dailyP
DIR_MergedDailyMap=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/daily
DIR_WeeklyComposite=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/weekly
DIR_CLIMAT=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/climate
DIR_Archive=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/archive
DIR_Meta=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/meta
DIR_Temp=/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/temp
      CONFIGURE_FILE_CONTENT = #Options for VIIRS-VH weekly job processing (produding
weekly composite, ND,SM and VH file)
[Options for VHsuite.exe]
ScalingParameters= 0.693565, -0.0297126, 1.01334, -2.3176  #Sep 2014, using 2 years' data
CompositeMethodMaxNDVI=1
DaysPerPeriod=7
PeriodsPerYear=52
FilterSize=15
smOutputOption=1
FilePrefix=ViirsVH
FilePrefixClimat=VHP
Resolution=4 KM
SatelliteID=npp
NumberOfTiles_X=1
NumberOfTiles_Y=1
DataSource= VHP

[Periods of GVI data used for VH]
# this section controls which satellite will be used for calculating ND, SM and VH
#satID satNumber yearWeek1 yearWeek2
NC 07 198135 198449
NF 09 198509 198845
NH 11 198846 199436
NJ 14 199504 200052
NL 16 200101 200401
```

```
NL 16 200405 200410
NL 16 200425 200428
NL 16 200430 200523
NN 18 200524 201152
NP 19 201201 201213
npp 101 201214 399999

[Periods of AVHRR data used for GVI climatology]
#this section controls which satellite will be used for creating VH climatology
#satID satNumber yearWeek1 yearWeek2
NC 07 198142 198450
NF 09 198515 198752
NH 11 198920 199252
NJ 14 199520 199952
NL 16 200120 200252
NN 18 200601 201052
NP 19 201101 201152
[END]
      Conventions = CF-1.5
      DAYS_PER_PERIOD = 7
      INPUT_FILENAMES =
/opt/data/nde/NDE_ALGTEST/pgs/working/447969/data/VH/ViirsVH.G04.C07.npp.P2015010.SM.n
c
/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/climate/VHP.G04.C07.CLIMAT.P10.nc
      INPUT_FILES = 2
      Metadata_Conventions = CF-1.5, Unidata Dataset Discovery v1.0
      PCF_FILE_CONTENT =
#
# name: /opt/data/nde/NDE_ALGTEST/pgs/working/447969/ViirsVH_weekly.pcf
#
# working directory: /opt/data/nde/NDE_ALGTEST/pgs/working/447969
# ProdRuleName: VH Weekly Temporal Rule v1.7
#
working_directory=/opt/data/nde/NDE_ALGTEST/pgs/working/447969
nde_mode=NDE_ALGTEST
job_coverage_start=201504230000000
job_coverage_end=201504300000000
DIR_BIN=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/bin
File_Configure=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/control/VHconfig.viirs_weekly_4
km
satelliteID=npp
DIR_CLIMAT=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/climate
File_Metadata_Regions=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/ancillary/regions_for_m
etadata.txt
File_Static_Metadata=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/ancillary/vgvi_static_meta
data.txt
File_IGBPLandTypes=/opt/apps/nde/NDE_ALGTEST/algorithms/VH/v1.7/ancillary/gigbp2_landtype
_11.hdf
DailyMap=ViirsVH4kmDaily_npp_s201504230000000_e201504230600000_c201504230702339.nc
```

……(skip 26 Daily Maps here)
DailyMap=ViirsVH4kmDaily_npp_s201504291800000_e201504300000000_c201504300108446.nc
ND_FILE=GVH4kmND_npp_s201501150000000_e201501212359599_c201502110000000.nc
…..(13 ND FILE were not shown)
ND_FILE=GVH4kmND_npp_s201504160000000_e201504222359599_c201504290000000.nc
#END-of-PCF
PERIOD_OF_YEAR = 10
PRODUCT_NAME = VH_2015_Week_10
PROJECTION = Plate Carree
YEAR = 2015
cdm_data_type = grid
creator_email = Felix.kogan@noaa.gov
creator_name = DOC/NOAA/NESDIS/STAR > VHP Team, Center for Satellite Applications and Research, NESDIS, NOAA, Department of Commerce
creator_url = http://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/
geospatial_lat_max = 75.024
geospatial_lat_min = -55.151993
geospatial_lat_units = degrees_north
geospatial_lon_max = 179.99997
geospatial_lon_min = -180.0
geospatial_lon_units = degrees_east
history = Version 1
institution = DOC/NOAA/NESDIS/NDE > S-NPP Data Exploitation, NESDIS, NOAA, U.S. Department of Commerce
instrument_name = VIIRS
naming_authority = gov.noaa.nesdis.nde
processing_level = NOAA Level 3
project = S-NPP Data Exploitation
publisher_email = espcoperations@noaa.gov
publisher_name = DOC/NOAA/NESDIS/NDE > S-NPP Data Exploitation, NESDIS, NOAA, U.S. Department of Commerce
publisher_url = http://projects.osd.noaa.gov/NDE
references = User Guide of Vegetation Health (VH version 1.0,2014)
satellite_name = npp
source = VIIRS-I1-SDR, VIIRS-I2-SDR, VIIRS-I5-SDR, ICCMO
standard_name_vocabulary = CF Standard Name Table (version 17, 24 March 2011)
summary = Vegetation Health Product
time_coverage_end = 201503112359599
time_coverage_start = 201503050000000
title = VH_2015_Week_10
version = version 1.6, Feb 10 2015

2. ALGORITHM

2.1. Algorithm Overview

Provide a high-level description of the algorithm, including a reference to the ATBD, if available. *(Document Object 27)*
Writers: Algorithm Scientists.

The Visible Infrared Imager Radiometer Suite (VIIRS) provides advanced imaging and radiometric capabilities from NPP spacecraft and the next generation JPSS.VIIRS Visible and near infrared channels (I1 – 0.64µm, I2 - 0.86µm) are used to produce the NDVI and infrared band (I5 – 11.0-12.0 µm) are used to produce Brightness Temperature (BT). Derived indices from NDVI and BT will be used to develop VH product.

For each day, VIIRS data are projected to a grid map with geo-graphic projection by selecting pixels closest to the center of grid cell. In order to pick cloud free pixels, 7 days maximum NDVI compositing is applied. Noise in NDVI and BT time series is further reduced by a digital filter.

After noise removal, weather-driven differences in NDVI and BT between the years become apparent: lower NDVI and higher BT in dry years and opposite in normal and wet years. This principle of comparing NDVI and BT for a particular year with their dry-wet range calculated from 30-year observations was laid down in the VH algorithm development and was based on the three laws: Law-of-Minimum, Law –of –Tolerance and Carrying Capacity. The absolute maximum and minimum of NDVI and BT during 1981-2005 were calculated for each of the 52 weeks and for each pixel. They were then used as the criteria to estimate the upper (favorable weather) and the lower (unfavorable weather) limits of the ecosystem resources. Further, for estimation of weather impacts on vegetation condition, NDVI and BT values for a particular time (year and week) were normalized relative to the absolute max/min interval. Following this procedure, NDVI and BT were rescaled based on equations below. They were named the Vegetation Condition Index (VCI), Temperature Condition Index (TCI) and Vegetation Health Index (VHI). These indices are designed to characterize moisture (VCI), thermal (TCI) and total vegetation health (VHI) conditions in response to weather impacts

$$VCI=100*(NDVI-NDVImin)/(NDVImax-NDVImin) \quad (1)$$

$$TCI=100*(BTmax - BT)/(BTmax - BTmin) \quad (2)$$

$$VHI = a*VCI + (1- a)*TCI \quad (3)$$

where NDVI, NDVImax, and NDVImin (BT, BTmax, and BTmin) are the noise reduced (smoothed) weekly NDVI (BT), their multi-year absolute maximum, and minimum, respectively. The VCI, TCI and VHI approximate the weather component in NDVI, BT and their combination values. They fluctuate from 0 to 100, reflecting changes in vegetation conditions from extremely bad to optimal. The weighting factor (a) in equation 3 was determined by experience, currently, a=0.5).

2.2. Input Satellite Data

2.2.1. Satellite Instrument Overview

High-level description of the satellite and instrument that provides the input data, including spectral (range, channels/bands), spatial (scan pattern, footprint), and other features (e.g., instrument noise). *(Document Object 29)*
Writers: Development Lead and PAL should collaborate

The Visible Infrared Imaging Radiometer Suite (VIIRS) provides critical data for accurately monitoring global weather and climate patterns aboard the Suomi National Polar-orbiting Partnership (NPP) spacecraft and future next-generation weather satellites.

Suomi NPP is a bridge mission between the current polar weather satellite system and The National Oceanic and Atmospheric Administration's Joint Polar Satellite System. VIIRS represents the latest in a series of progressively capable technologies meteorologists use to increase the precision of their weather forecasting. VIIRS replaces and improves upon sensing technology that in some cases is 30 years old. VIIRS provides highly detailed imagery of global storm patterns, with multi-band imaging capabilities that support the acquisition of high-resolution atmospheric imagery for a variety of other applied products, including detection of fires, smoke, and atmospheric aerosols. VIIRS also provides imagery of clouds under sunlit and nighttime conditions in about a dozen visible and infrared bands.

VIIRS Visible and near infrared channels (I1 – 0.64µm, I2 - 0.86µm) are used to produce the NDVI and infrared band (I5 – 11.0-12.0 µm) are used to produce Brightness Temperature (BT). Derived indices from NDVI and BT will be used to develop VH product. VIIRS image bands data are in 375m resolution (at nadir), organized by granules and stored as Sensor Data Record (SDR) files. Each granule covers observation of 1.5 minutes. There are about 1014 granules per day.

VIIRS geo-location file (GITGO file) provides latitude, longitude, sensor zenith and azimuth, solar zenith and azimuth for all pixels of a granule. VIIRS cloud mask intermediate product (IICMO) provides cloud information which helps to identify the quality of observation.

2.2.2. Satellite Data Preprocessing Overview

High-level description of the steps performed to produce input sensor data (e.g., L1, SDR). *(Document Object 30)*
Writers: Development Lead and PAL should collaborate

When VIIRS data arrive, geo-location files, sensor data records and cloud mask files may be duplicated or missing. Thus, the first step is to search the file list for each input data type, select a unique geo-location file for each granule (defined by observation time) and find matched SDR records.

Then, for each day, VIIRS data are projected to a grid map with geo-graphic projection by selecting pixels closest to the center of grid cell. In order to pick cloud free pixels, 7 days maximum NDVI compositing is applied. Noise in NDVI and BT time series is further reduced by a digital filter.

2.2.3. Input Satellite Data Description

Provide a high-level description of the input satellite data. Provide information on the various types of input data such as the source, instrument name, format, level of processing (e.g. L1B). *(Document Object 100)*
Writers: Development Lead and PAL should collaborate

Input data includes the following VIIRS SDR (L1B files in HDF5 format):

SVI01	Reflectance of image band 1
SVI02	Reflectance of image band 2
SVM03	Reflectance of MOD band 3
SVI05	temperature of image band 5
GITGO	solar_zenith
	sensor_zenith
	solar_azimuth
	sensor_azimuth
	Latitude and longitude
IICMO	Packed cloud mask (quality flag)

2.3. Input Ancillary Data

List each input file that contains ancillary data. Describe the ancillary data content of each file, either explicitly or by reference to the developer's design documents. This information may be in the developer's Detailed Design Document (DDD). Refer to the DDD in the developer's project artifact repository, if available. *(Document Object 32)*
Writers: Algorithm Scientists and Development Programmers should collaborate

VIIRS-VH system requires the following ancillary data:

- Static metadata file: contains parameters which will be inserted to product file as file attributes. It allows change the file attributes without modifying the source code.
- 1.1km Land sea mask
- IGBP land type
- Calibration files
- List of Regions for statistics: Contains spatial range of selected regions. Used to extract regional averaged data for metadata

3. PERFORMANCE

3.1. Product Testing

3.1.1. Test Data Description

Description of data sets used for V&V, including unit tests and system test, either explicitly or by reference to the developer's test plans, if available. This will be updated during operations to describe test data for maintenance. *(Document Object 31)*
Writers: Development Testers

Refer to VIIRS-VH_unitTestReport*.docx

3.1.2. Unit Test Plans

Describe all test plans that were produced during development, including links or references to the artifacts. *(Document Object 48)*
Writers: Development Testers

Refer to VIIRS-VH_unitTestReport*.docx

3.2. Product Accuracy

3.2.1. Test Results

Description of testing and test results performed during development, either explicitly or by references to test reports. If test reports are not available to external users, provide a summary of the test results in sufficient detail to give external users a good sense of how the test results indicate that the products meet requirements. *(Document Object 47)*
Writers: Development Testers

Refer to VIIRS-VH_unitTestReport*.docx

3.2.2. Product Accuracy

Accuracy of products, as measured by V&V testing, and compared to accuracy requirements. Refer to relevant test reports. *(Document Object 39)*
Writers: Algorithm Scientists and Development Testers should collaborate

3.3. Product Quality Output

Describe the quality flags that are included in the output product files. *(Document Object 38)*
Writers: Development Programmers

For VIIRS VH daily map and weekly composite file, SDS “packed_cloud_mask” serves as quality flags. The Snow flag is not set yet due to lack of operational global snow product. Cloud mask may be set if the input cloud mask data (obtained from IICMO) are available .

Table 3.1 Packed_cloud mask (CM) SDS in daily and weekly composite files

From the least significant bit (LSB)	Description
0	Invalid pixel
1	Is day time
2	Land
3	Coast
4	Sun glint
5	Snow -- not set ,
6-7	Cloud mask: (0~3), clear(0),partial-clear(1), partial-cloudy(2), cloudy(3)

For VIIRS-VH ND, SM, CLIMAT and VH files, SDS serves as quality flags. A pixel is invalid when all variables are missing (= fill value). If a variable has valid value, it still may not be meaningful if it is over an area without nature vegetation, for example, VCI over desert, water or very cold area.

Table 3.2 Quality Assurance (QA) SDS in ND, SM, CLIMAT and VH files.

From the least significant bit (LSB)	Description
0	Invalid pixel
1	Desert
2	Land
3	Coast
4	Too cold surface
5-7	Reserved

3.4. External Product Tools

Provide a description of each program and/or application that is supplied to external users for display and analysis of the product output files, including the purpose and function of the tool and how to operate them. This could also include readers for product files. You may also describe any files that may be supplied to an external user (e.g. BUFR tables, coefficient files, etc).*(Document Object 53)*
Writers: Development Programmers

HDFView software (and IDL program gvh.pro) can be used to read and display the VIIRS-VH products.

4. PRODUCT STATUS

4.1. Operations Documentation

Excerpts and/or references to operations documentation deemed of value to product users (e.g., relevant sections of operations event logs, System Maintenance Manual, and/or the Algorithm Theoretical Basis Document). *(Document Object 57)*
Writers: PAL

VIIRS-VH System Maintenance Manual (SMM)
VIIRS-VH ALGORITHM THEORETICAL BASIS DOCUMENT (ATBD):

4.2. Maintenance History

Excerpts and/or references to maintenance documentation deemed of value to product users (e.g., relevant sections of maintenance reports). *(Document Object 58)*
Writers: PAL

NA

END OF DOCUMENT