Suomi-NPP VIIRS Surface Reflectance User's Guide

V1 Re-processing (NASA Land SIPS)

Principal Investigator: Dr. Eric F. Vermote

Correspondence e-mail address: Eric.F.Vermote@nasa.gov

Prepared by J. C. Roger, E. F. Vermote, S. Devadiga and J. P. Ray

Version 1.1

October 2016

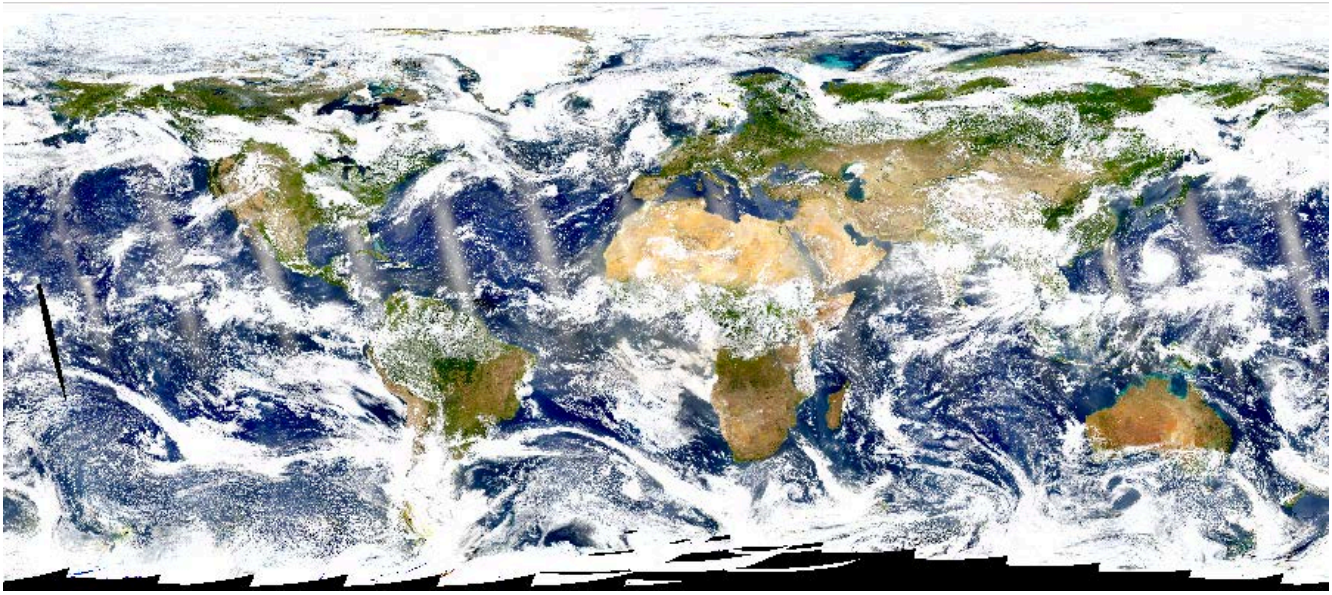


Table of Contents

1. Introduction. **5**

2. Overview of VIIRS/NPP Land SIPS V1 Processing **6**
- **2.1. VIIRS surface reflectance data products** **6**
- **2.2. NPP/ VIIRS Level 2 Surface Reflectance Product Description** **7**
- **2.3. NPP/ VIIRS Level 2G Surface Reflectance Product Description** **7**
- **2.4. NPP/ VIIRS Level 3 Surface Reflectance Product Description** **9**

3. Detailed product descriptions **10**
- **3.1. Description of Science Data Sets ON DEMAND** **10**
  - **3.1.1. VNP09** 10
  - **3.1.3. VNP09G1KI** 14
  - **3.1.4. VNP09GHKI** 17
- **3.2. Description of ARCHIVED Science Data Sets** **19**
  - **3.2.1. VNP09GA** 19
  - **3.2.2. VNP09A1** 25
  - **3.2.3. VNP09H1** 27
  - **3.2.4. VNP09CMG** 29
- **3.3. Data product quality & state QA flags** **32**
- **3.4. Number Mapping** **41**
- **3.5. Orbit and coverage** **41**

4. Caveats and Known Problems **42**

5. Data ordering (& browsing) **42**
- **5.1. Where can I browse data** **42**
- **5.2. Where to get data from** **42**
- **5.3. Data product granule ID** **42**
- **5.4. Data viewing tools (not inclusive).** **43**

List of Tables

Table 1. *VIIRS bands included in Surface Reflectance products and nearest equivalent MODIS bands (not exact matches).* 5
Table 2. *Land surface reflectance products produced by Land SIPS V1 reprocessing* 7
Table 3. *Science Data Sets for VNP09.* 11
Table 4. *Science Data Sets for VNP09G1KI.* 14
Table 5. *Science Data Sets for VNP09GHKI.* 17
Table 6. *Science Data Sets for VNP09GA* 19
Table 7. *Science Data Sets for VNP09A1.* 25
Table 8. *Science Data Sets for VNP09H1* 27
Table 9. *Science Data Sets for VNP09CMG.* 30
Table 10. *Surface Reflectance Quality Flags **QF1** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).* 32
Table 11. *Surface Reflectance Quality Flags **QF2** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).* 32
Table 12. *Surface Reflectance Quality Flags **QF3** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).* 33
Table 13. *Surface Reflectance Quality Flags **QF4** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).* 34
Table 14. *Surface Reflectance Quality Flags **QF5** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).* 34
Table 15. *Surface Reflectance Quality Flags **QF6** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).* 35
Table 16. *Surface Reflectance Quality Flags **QF7** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).* 36
Table 17. *Surface Reflectance Band Quality Control Description (16-bit). Bit 0 is LSB.* 37
Table 18. *Surface Reflectance Band Quality Control Description (32-bit). Bit 0 is LSB.* 38
Table 19. *Surface Reflectance State QA description (16-bit). Bit 0 is LSB.* 39
Table 20. *Surface Reflectance CMG State QA description (16-bit). Bit 0 is LSB.* 40
Table 21. CMG Number Mapping (32-bit). Bit 0 is LSB. 41
Table 22. CMG Number Mapping (32-bit). Bit 0 is LSB. 41
Table 23. *Orbit and coverage data set (8-bit). Bit 0 is LSB.* 41

List of Figures

Figure 1. An RGB-image derived from VNP09CMG.A2015217.001.2016199113723.h5 6
Figure 2. The NPP/VIIRS sinusoidal grid consists of 460 non-overlapping tiles which measure approximately 10° x 10°. Data from an example tile (tile h11v05, derived from VNP09G1KI.A2015293.h11v05.C1_03002.2015295110654.hdf) is shown as an RGB-image..... 8
Figure 3. A VNP09 750m RGB-image composed of surface reflectance measured by VIIRS bands M3 (red), M4 (green) and M5 (blue) October 09, 2015 over UK, France and Spain. Product granule ID: 10
Figure 4. A VNP09 RGB-image composed of surface reflectance measured by VIIRS bands I1, I2 and I3 on October 09, 2015 over UK, France and Spain. Product granule ID:..... 10
Figure 5. RGB (M3, M4 and M5) VNP09G1KI product on August 6th 2015. Product granule ID:..... 14
Figure 6. RGB (I1, I2 and I3) VNP09GHKI product on August 6th 2015. Part of the Product granule ID: 17
Figures 7. A VIIRS VNP09GA product composed of surface reflectance data measured by bands M3, M4 and M5 (Top) and I1, I2 and I3 (Bottom) on October 10th 2015 over the West Africa coast. Granule ID: 19
Figure 8. RGB VNP09A1 product composed of surface reflectance data measured by bands I1, I2 and I3 on October 8th, 2015 over the Eastern America. Granule ID is..... 25
Figure 9. RGB VNP09H1 product composed of surface reflectance data measured by bands I1, I2 and I3 on October 8th, 2015 over the South of France. Part of the Granule ID :..... 27
Figure 10. A VNP09CMG RGB-image composed of surface reflectance from bands M3 (Blue), M4 (Green) and M5 (Red) on August 5, 2015. Product granule ID: VNP09CMG.A2015217.001.2016199113723.h5 29
Figure 11. A VNP09CMG image composed of surface reflectance from bands I1 (Near Infrared) and I2 (Red)..... 29

1. Introduction.

Most satellite data processing systems recognize five distinct levels of processing. Level 0 data is raw satellite feeds: Level 1 data has been radiometrically calibrated, but not otherwise altered. Level 2 data is Level 1 data that has been atmospherically corrected to yield a surface reflectance product. Level 3 data is Level 2 data that has been gridded into a map projection, and usually has also been temporally composited or averaged. All data up to and including Level 2 are in an ungridded orbital swath format, with each swath typically cut into small segments, or ***granules***, to facilitate processing. Data at level 3 are geolocated into a specific map projection, with the geolocated products typically in a set of non-overlapping ***tiles***.

The advantage of Level 3 (L3) data over less processed forms of data is that each pixel of L3 data is precisly geolocated; a disadvantage is that the process of compositing or averaging that results in L3 data limits the usefulness of the L3 product. The Level 2G format, consisting of gridded Level 2 data, was developed as a means of separating geolocation from compositing and averaging. The L2G format preserves all the data from a day that maps to a given pixel as observations at that pixel. Programs which produce Level 3 data can then have all available data at each pixel to choose from, without having to geolocate everything themselves. An additional step of processing, Level 2G-lite, provides a minimal level of compositing of daily Level 2G data, storing only one best observation from each orbit overpassing the pixel.

Land surface reflectance for each pixel and for 12 bands (see Table 1) is obtained by adjusting top-of-atmosphere reflectance to compensate for atmospheric effects. Corrections are made for the effects of molecular gases, including ozone and water vapor, and for the effects of atmospheric aerosols. The inputs to the surface reflectance algorithm are top-of-atmosphere reflectances for the VIIRS visible bands (VNP02MOD, VNP02IMG), VIIRS cloud mask (VNP03), aerosol optical thickness and aerosol models (VNP04, VNPAMI_L2), and atmospheric data obtained from NCEP reanalysis (surface pressure, atmospheric precipitable water and ozone concentration).

Table 1. *VIIRS bands included in Surface Reflectance products and nearest equivalent MODIS bands (not exact matches).*

Band Name[a]	Band center (µm)	Bandwidth[b] (µm)	Nearest equivalent MODIS band
M1	.415	.020	8
M2	.445	.018	9
M3	.490	.020	3
M4	.555	.020	4
I1	.640	.080	1
M5	.673	.020	1
I2	.865	.039	2
M7	.865	.039	2
M8	1.24	.020	5
I3	1.61	.060	6
M10	1.61	.060	6
M11	2.25	.050	7

[a] M indicates band with a nadir resolution of 750 m, I indicates band with a nadir resolution of 375 m.
[b] full width half maximum (FWHM)

2. Overview of VIIRS/NPP Land SIPS V1 Processing

Land surface reflectance is the fraction of incoming radiation at a particular wavelength or bandpass that is reflected from the land surface. The Suomi NPP VIIRS surface reflectance products are estimates of surface reflectance in each of the VIIRS reflective bands I1-I3, M1-M5, M7, M8, M10, and M11. Level 2 surface reflectance product is produced for the same swath data sets as the Land SIPS V1 Level 1B swaths, each of which contains approximately six minutes' worth of data. Surface reflectance for each moderate-resolution (750m) or imagery-resolution (375m) pixel is retrieved separately for the Level 2 products. Level 2G and Level 3 products are generated by performing spatial and temporal aggregation to 500m or 1km grids, over daily or 8-day time periods.

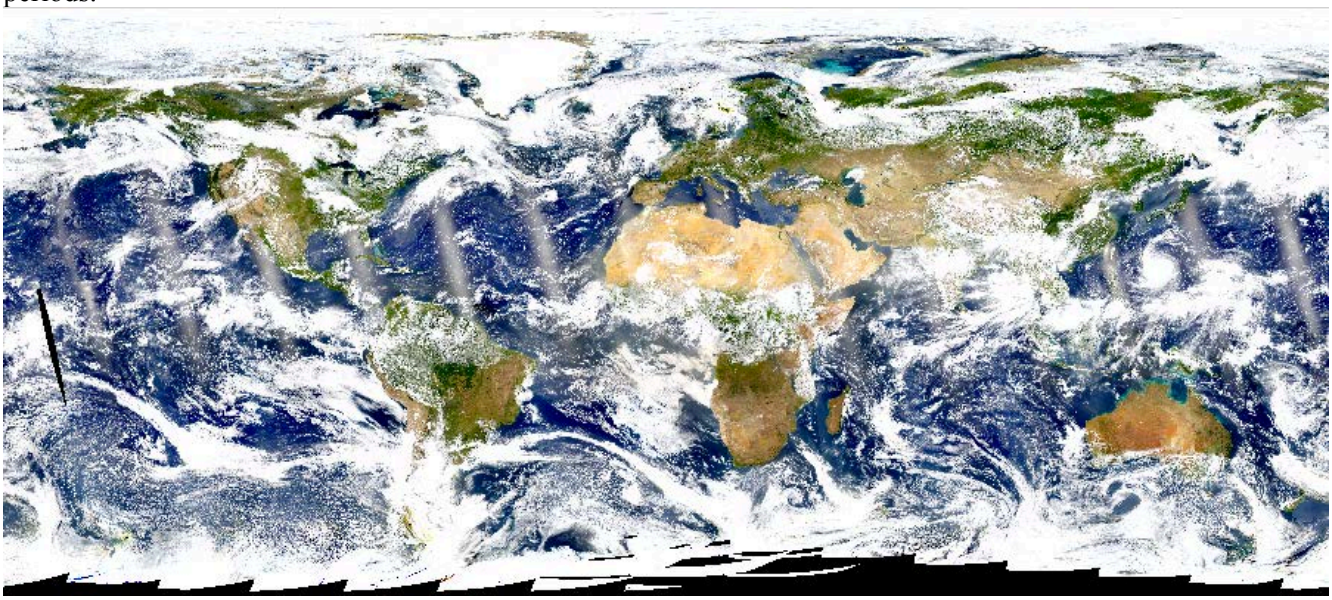


Figure 1. An RGB-image derived from VNP09CMG.A2015217.001.2016199113723.h5

2.1. VIIRS surface reflectance data products

The following surface reflectance products are generated at the Land SIPS: One Level 2 VIIRS surface reflectance product (VNP09), three Level 2G surface reflectance products (VNP09GA, VNP09G1KI, and VNP09GHKI), a global CMG-grid daily L3 surface reflectance (VNP09CMG), and two multi-day surface reflectance products (VNP09A1 and VNP09H1). See Table 2.

The L2 product, VNP09 and the daily L2G products VNP09GHK1 and VNP09G1KI are available from AS 5000 of LAADS (Level 1 and Atmosphere Archive and Distribution System, http://ladsweb.nascom.nasa.gov) only. VNP09 are available in the archive for all data days processed at SIPS, whereas the VNP09GHK1 and VNP09G1KI products from the last 40 data days are available online and the remaining days are only available on demand at LAADS-POD (Processing On Demand). The other products VNP09GA, VNP09A1, VNP09H1 and VNP09CMG are archived and distributed from both LAADS and LP-DAAC. This User's Guide is meant to be a guide for the use of publically available products.

Table 2. *Land surface reflectance products produced by Land SIPS V1 reprocessing*

Products	ESDT	Description
Surface Reflectance (L2 Daily Swath product)	VNP09 *Available @LAADS*	VIIRS/NPP Surface Reflectance 5-Min Swath IP 375m and 750m Bands I1-I3, M1-M5, M7-M8, M10-M11. Output is in hdf 4 format
Surface Reflectance (L2G Daily Tiled products)	VNP09G1KI *Available for the latest 40 days @LAADS and for any prior days on de-mand @LAADS-POD*	VIIRS/NPP Surface Reflectance Daily L2G Global DDR 1km SIN Grid Day. Bands M1- M5, M7-M8, M10-M11. Input is VNP09 and output is in hdf 4 format
	VNP09GHKI *Available for the latest 40 days @LAADS and for any prior days on de-mand @LAADS-POD*	VIIRS/NPP Surface Reflectance Daily L2G Global DDR 500m SIN Grid Day. Bands I1- I3 Input is VNP09 and output is in hdf 4 format
	VNP09GA *Archived @LAADS and @LP_DAAC*	VIIRS/NPP Surface Reflectance Daily 1km and 500m L2G lite Bands I1- I3 (500m), Bands M1- M5, M7-M8, M10-M11 (1 Km) Inputs are VNP09G1KI and VNP09GHKI and output is in hdf5
Surface Reflectance (L3 8-day Composite Products)	VNP09A1 *Archived @LAADS and @LP_DAAC*	VIIRS/NPP 8-Day Surface Reflectance L3 1km SIN Grid. Bands M1- M5, M7-M8, M10-M11. Input is VNP09G1K1 and output is in hdf5
	VNP09H1 *Archived @LAADS and @LP_DAAC*	VIIRS/NPP 8-Day Surface Reflectance L3 500m SIN Grid. Bands I1- I3 Input is VNP09GHK1 and output is in hdf5
Surface Reflectance (L3 Daily CMG Products)	VNP09CMG *Archived @LAADS and @LP_DAAC*	VIIRS/NPP Daily Surface Reflectance L3 Global DDR 0.05°x0.05° grid CMG. Bands I1- I3, M1- M5, M7-M8, M10-M11 (M12-16 also added) Inputs are VNP09 and output is in hdf5

LAADS: Level 1 and Atmosphere Archive and Distribution System (https://ladsweb.nascom.nasa.gov)
LP_DAAC: Land Process Distributed Active Archive Center (https://lpdaac.usgs.gov)
POD: Processing On Demand

2.2. NPP/ VIIRS Level 2 Surface Reflectance Product Description

All surface reflectance products are produced under daytime conditions only. The product is produced under all atmospheric conditions except for night. Pixels, when not produced, are replaced by fill values in the Level 2 products, and are not included in the Level 3 products.

2.3. NPP/ VIIRS Level 2G Surface Reflectance Product Description

The NPP/ VIIRS Level 2G surface reflectance products are composed of all available surface reflectance observations for a given day over a set of tiles with global coverage. The tile numbering scheme and boundaries are the same as they are for MODIS. The first set of observations for each data set and grid cell are stored as a two-dimensional data set. Additional data layers are stored in a compacted format. Pixels, when not produced, are replaced by fill values in the Level 2G products, and are not included in the Level 3 products.

The Land SIPS V1 reprocessing produces three Level 2G surface reflectance products, one containing data from the moderate-resolution bands projected to a 1km grid (VNP09G1KI), one containing data from the imagery-resolution bands projected to a 500m grid (VNP09GHKI), and one containing both the moderate-resolution and imagery-resolution bands along with sun/sensor geometry fields (VNP09GA). The 500m and 1km resolution Level 2G products are generated using imagery-resolution pointer data.

The algorithm runs for each tile in the sinusoidal grid (Figure 1) for each day, and is run on all NPP/VIIRS Level 2 granules that map to the tile for that day. The number of observations at each pixel is determined not only by the number of orbits at that location (one at the equator and up to 15 at the poles), but also by the spread of observational coverage of off-nadir pixels. Tiles with no land pixels are not processed.

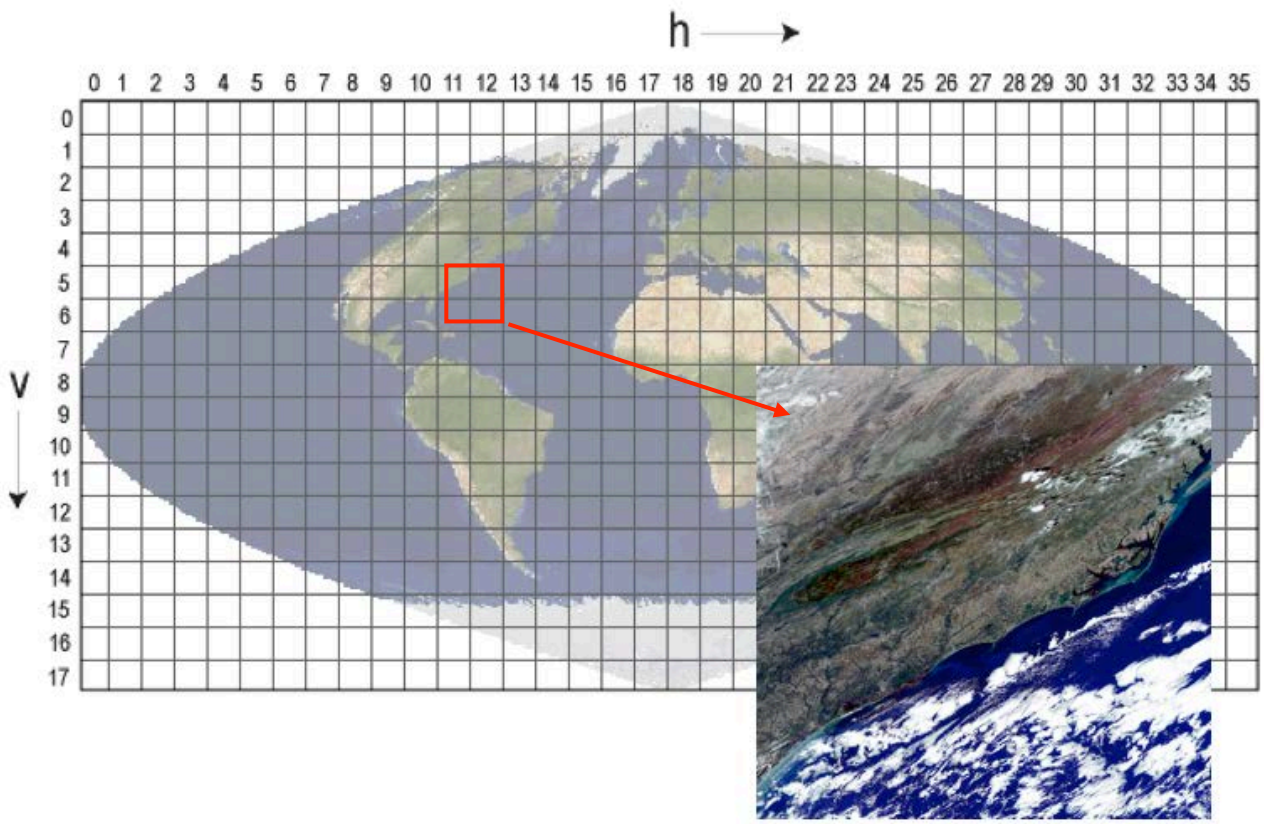


Figure 2. The NPP/VIIRS sinusoidal grid consists of 460 non-overlapping tiles which measure approximately 10° x 10°. Data from an example tile (tile h11v05, derived from VNP09G1KI.A2015293.h11v05.C1_03002.2015295110654.hdf) is shown as an RGB-image.

2.4. NPP/ VIIRS Level 3 Surface Reflectance Product Description

There are three Level 3 surface reflectance products produced by the Land SIPS V1 reprocessing, one global CMG-grid daily, and two 8-day tiled composite products. The Level 3 daily CMG product, VNP09CMG, is produced at 0.05 degree resolution on a global grid. One of the 8-day tiled products, VNP09A1, is produced at 1km resolution, and the other, VNP09H1, is produced at 500m resolution.

Each of the products is produced for a subset of the VIIRS reflective bands.. VNP09H1 is produced for bands I1-I3, VNP09A1 is produced for M1-M5, M7, M8, M10, and M11 and VNP09CMG is produced for bands I1-I3, M1-M5, M7, M8, M10, and M11.

In the Land SIPS V1 versions of the surface reflectance products, all daytime pixels are processed, but lower quality data are not used in the Level 3 composites where higher quality data are available.

For each pixel, the compositing steps are:

1) Observations from the same orbit are composited by observational coverage. Observations with the highest coverage are saved, and the rest discarded. This yields a list of one observation from each orbit.
2) Each orbit's observation is then assigned a score, based upon whether it is flagged for cloud, cloud shadow, high aerosol or low aerosol, or contains high view angle or low solar zenith angle. The lowest score, 0, is assigned to observations with fill values for data. The remaining scores are:

1 BAD data derived from a faulty or poorly corrected L1B pixel
2 HIGHVIEW data with a high view angle (60 degrees or more)
3 LOWSUN data with a high solar zenith angle (85 degrees or more)
4 CLOUDY data flagged as cloudy or adjacent to cloud
5 SHADOW data flagged as containing cloud shadow
6 UNCORRECTED data flagged as uncorrected
7 CLIMAEROSOL data flagged as containing the default level of aerosols
8 HIGHAEROSOL data flagged as containing the highest level of aerosols
9 SNOW data flagged as snow
10 GOOD data which meets none of the above criteria

The observation with the highest score and the lowest view angle is selected for the VNP09A1 and VNP09H1 outputs.

3. Detailed product descriptions

3.1. Description of Science Data Sets ON DEMAND

3.1.1. VNP09

VIIRS/NPP Surface Reflectance 6-minute L2 Swath IP 375m and 750m (hdf 4 format)

Product description: The Surface Reflectance IP algorithm provides VIIRS surface reflectance for bands M1, M2, M3, M4, M5, M7, M8, M10 and M11 at 750m resolution and for bands I1, I2, I3 at 375m resolution. It also provides data Quality flags

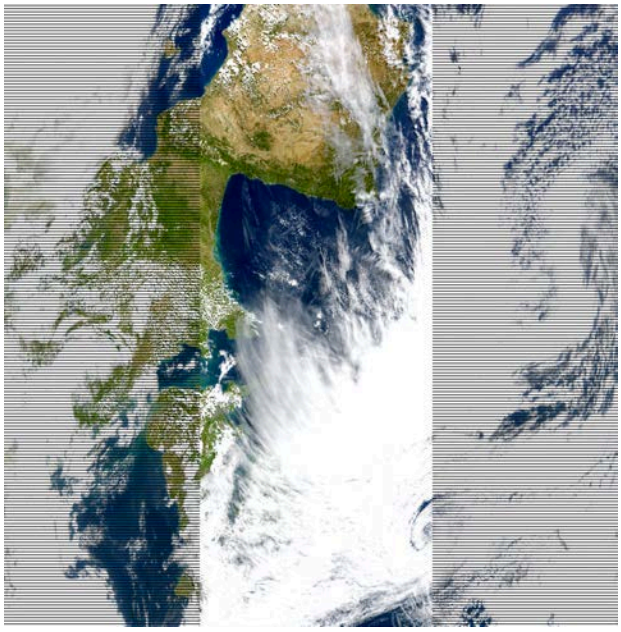


Figure 3. A VNP09 750m RGB-image composed of surface reflectance measured by VIIRS bands M3 (red), M4 (green) and M5 (blue) October 09, 2015 over UK, France and Spain. Product granule ID: VNP09.A2015282.1318.001.2016207155654.hdf

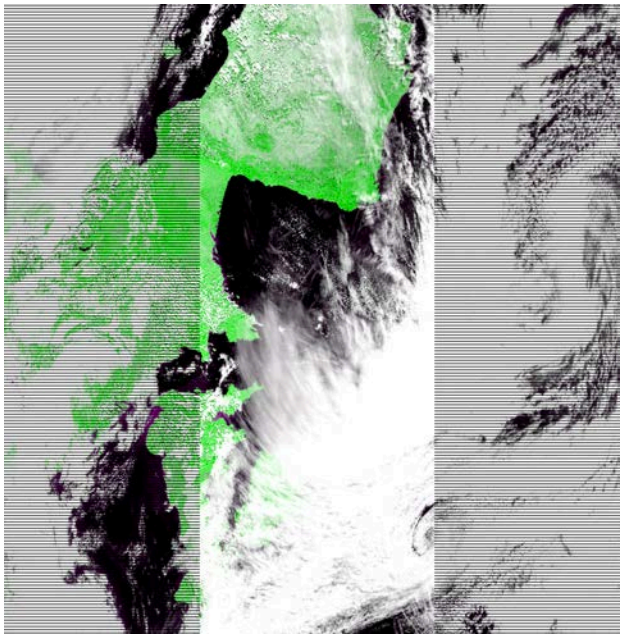


Figure 4. A VNP09 RGB-image composed of surface reflectance measured by VIIRS bands I1, I2 and I3 on October 09, 2015 over UK, France and Spain. Product granule ID: VNP09.A2015282.1318.001.2016207155654.hdf

The fill values at the edge of the swath are from on-board deletion of observations.

Table 3. *Science Data Sets for VNP09.*

Data Group	Science Data Sets (HDF Layers (16))	Units	Data Type	Fill Value	Valid Range	Scale Factor
375 m	375 m Surface Reflectance Band I1	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
375 m	375 m Surface Reflectance Band I2	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
375 m	375 m Surface Reflectance Band I3	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M1	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M2	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M3	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M4	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M5	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M7	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M8	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M10	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
750 m	750 m Surface Reflectance Band M11	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.001
	Surface Reflectance Quality Flags 1 *(see* **Table 10***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 2 *(see* **Table 11***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 3 *(see* **Table 12***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 4 *(see* **Table 13***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 5 *(see* **Table 14***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 6 *(see* **Table 15***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 7 *(see* **Table 16***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA

Description of Metadata: Example of VNP09.A2016273.1200.001.2016273222159.hdf

InputPointer =
VNP35_L2.A2016273.1200.001.2016273220523.hdf,VNPAMI_L2.A2016273.1200.001.2016273221211.hdf,VNP04_L2.A2016273.1200.001.2016273221211.hdf,VNP_PRWIP_L2.A2016273.1200.001.2016273213745.hdf,VNP_COZIP_L2.A2016273.1200.001.2016273213745.hdf,VNP_PRESIP_L2.A2016273.1200.001.2016273213745.hdf,NPP_IMFTS_L1.A2016273.1200.001.2016273211500.hdf,NPP_VIAES_L1.A2016273.1200.001.2016273213858.hdf,NPP_VMAES_L1.A2016273.1200.001.2016273213858.hdf,NPP_VMAES_L1.A2016273.1200.001.2016273213858.hdf
AncillaryInputPointer =
VNP35_L2.A2016273.1200.001.2016273220523.hdf,VNPAMI_L2.A2016273.1200.001.2016273221211.hdf,VNP04_L2.A2016273.1200.001.2016273221211.hdf,VNP_PRWIP_L2.A2016273.1200.001.2016273213745.hdf,VNP_COZIP_L2.A2016273.1200.001.2016273213745.hdf,VNP_PRESIP_L2.A2016273.1200.001.2016273213745.hdf,NPP_IMFTS_L1.A2016273.1200.001.2016273211500.hdf,NPP_VMAES_L1.A2016273.1200.001.2016273213858.hdf
NorthBoundingCoord = 61.251
WestBoundingCoord = -17.7895
EastBoundingCoord = 32.9793
SouthBoundingCoord = 35.1087
OrbitNumber = 25511.0
GRingLatitude = 40.315853,35.10873,53.387154,61.024494
GRingLongitude = 32.223904,-2.2837927,-17.789474,32.979267
Unagg_DayNightFlag = TS 0: Day; TS 1: Day; TS 2: Day; TS 3: Day; TS 4: Day
DayNightFlag = Day
PGE_StartTime = 2016-09-29 12:00:00.000
PGE_EndTime = 2016-09-29 12:06:00.000
LocalGranuleID = VNP09.A2016273.1200.001.2016273222159.hdf
RangeBeginningDate = 2016-09-29
RangeBeginningTime = 12:00:00.000000
RangeEndingDate = 2016-09-29
RangeEndingTime = 12:06:00.000000
ProductionDateTime = 2016-09-29 22:21:59.000
ShortName = VNP09
DataResolution = Imagery and Moderate
PGENumber = 511
PGE_Name = PGE511
PGEVersion = 1.0.5
SensorShortname = VIIRS
PlatformShortName = NPP
LongName = VIIRS/NPP Atmospherically Corrected Surface Reflectance 6-Min L2 Swath 375m, 750m
Product_doi = 10.5067/VIIRS/NPP/VNP09.v001
Product_authority = http://dx.doi.org
ProcessingCenter = MODAPS, NASA GSFC
ProcessingEnvironment = Linux minion5842 2.6.18-410.el5 #1 SMP Wed May 11 06:00:14 EDT 2016 x86_64 x86_64 x86_64 GNU/Linux
VersionID = VP2.4.4.1
PercentLand = 73.00109
PercentWater = 26.998909
PercentCloud = 49.48795
QAPercentGoodQuality = 73.30229
QAPercentOtherQuality = 26.697704
QAPercentNotProduced = 0.0
ProductionTime = 2016-09-29 21:38:58.000
NumSCEA_RDR_TimeSegments = [5]
LUTs_used = VIIRS-SR-IP-AC-INT_v1.5.06.02_LP,VIIRS-SR-AOTValues-LUT_v1.5.06.02_LP,VIIRS-SR-SolZenAngles-LUT_v1.5.06.02_LP,VIIRS-SR-SatZenAngles-LUT_v1.5.06.02_LP,VIIRS-SR-IncScatAngles-LUT_v1.5.06.02_LP,VIIRS-SR-ScatAngDims-LUT_v1.5.06.02_LP,VIIRS-SR-DownTrans-LUT_v1.5.06.02_LP,VIIRS-SR-SphAlb-LUT_v1.5.06.02_LP,VIIRS-SR-AtmReflect-LUT_v1.5.06.02_LP

EndingTime = 120600.000
Ending_Time_IET = [1.853842e+15]
Beginning_Time_IET = [1.8538416e+15]
StartTime = 2016-09-29 12:00:00.000
LSIPS_AlgorithmVersion = NPP_PRSRefl 1.0.1
AlgorithmType = OPS
ProcessVersion = 001
SatelliteInstrument = NPP_OPS
BeginningTime = 120000.000
EndTime = 2016-09-29 12:06:00.000
NumSci_RDR_TimeSegments = [5]

3.1.3. VNP09G1KI

VIIRS/NPP Surface Reflectance Daily L2G Global DDR 1 km SIN Grid day (hdf 4 format)

Product description: VNP09G1KI provides daily VIIRS/NPP surface reflectance at 1km for bands M1-5, M7-8, M10-11. All observations during a 24-hour period within a minimum observation coverage, as determined by overall pixel quality and observational coverage, are matched geographically according to corresponding 1 km Pointer Files. Quality information for this product is provided at three different levels of detail: for individual pixels, for each band and each resolution, and for the whole file. Observations are not ordered according to any quality instead they are just based on ordered input granules.

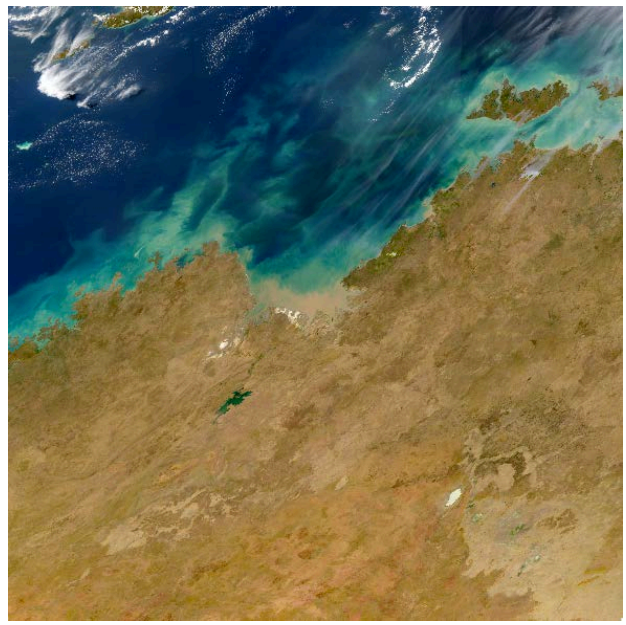


Figure 5. RGB (M3, M4 and M5) VNP09G1KI product on August 6th 2015. Product granule ID: VNP09G1KI.A2015218.h30v10.001.2016199180039.hdf

Table 4. *Science Data Sets for VNP09G1KI.*

Data Group	Science Data Sets (HDF Layers (36))	Units	Data Type	Fill Value	Valid Range	Scale Factor
1 km	1km Surface Reflectance M1 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M2 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M3 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M4 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001

	1km Surface Reflectance M5 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M7 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M8 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M10 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M11 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	Surface Reflectance Quality Flags 1 *first layer _1* *(see* **Table 10***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 2 *first layer _1* *(see* **Table 11***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 3 *first layer _1* *(see* **Table 12***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 4 *first layer _1* *(see* **Table 13***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 5 *first layer _1* *(see* **Table 14***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 6 *first layer _1* *(see* **Table 15***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 7 *first layer _1* *(see* **Table 16***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Orbit and Coverage *first layer _1* *(see* **Table 23***)*	Bit field	8-bit unsigned integer	15	0 - 255	NA
	Number of observations	None	8-bit signed integer	-1	0 - 127	NA
1 km	1km Surface Reflectance M1 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M2 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M3 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M4 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M5 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M7 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001

	1km Surface Reflectance M8 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M10 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	1km Surface Reflectance M11 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	Surface Reflectance Quality Flags 1 *compact layer _c (see* **Table 10***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 2 *compact layer _c (see* **Table 11***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 3 *compact layer _c (see* **Table 12***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 4 *compact layer _c (see* **Table 13***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 5 *compact layer _c (see* **Table 14***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 6 *compact layer _c (see* **Table 15***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Surface Reflectance Quality Flags 7 *compact layer _c (see* **Table 16***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
	Orbit and Coverage *compact layer _c (see* **Table 23***)*	Bit Field	8-bit unsigned integer	15	0 - 255	NA
	Number of additional observations per row	None	32-bit signed integer	-1	0-2147483647	NA

3.1.4. VNP09GHKI

VIIRS/NPP Surface Reflectance Daily L2G Global DDR 500 m SIN Grid day (hdf 4 format)

Product description: VNP09GHKI provides daily VIIRS/NPP surface reflectance at 500 m for bands I1, I2 and I3. The best observations during a 24-hour period within a minimum observation coverage, as determined by overall pixel quality and observational coverage, are matched geographically according to corresponding 500 m Pointer Files. Quality information for this product is provided at three different levels of detail: for individual pixels, for each band and each resolution, and for the whole file. Observations are not ordered according to any quality instead they are just based on ordered input granules.

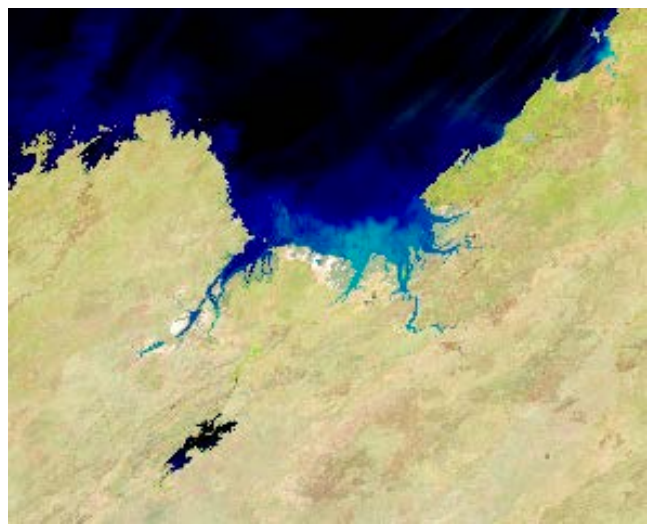


Figure 6. RGB (I1, I2 and I3) VNP09GHKI product on August 6th 2015. Part of the Product granule ID: VNP09GHKI.A2015218.h30v10.001.2016199180039.hdf

Table 5. *Science Data Sets for VNP09GHKI.*

Data Group	Science Data Sets (HDF Layers (10))	Units	Data Type	Fill Value	Valid Range	Scale Factor
500 m	Surface Reflectance I1 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
500 m	Surface Reflectance I2 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
500 m	Surface Reflectance I3 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	Orbit and Coverage *first layer _1 (see* **Table 23***)*	Bit field	8-bit unsigned integer	15	0 - 255	NA
	Number of observations	None	8-bit signed integer	-1	0 - 127	NA
500 m	Surface Reflectance I1 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
500 m	Surface Reflectance I2	Reflectance	16-bit signed	-28672	-100 - 16000	0.0001

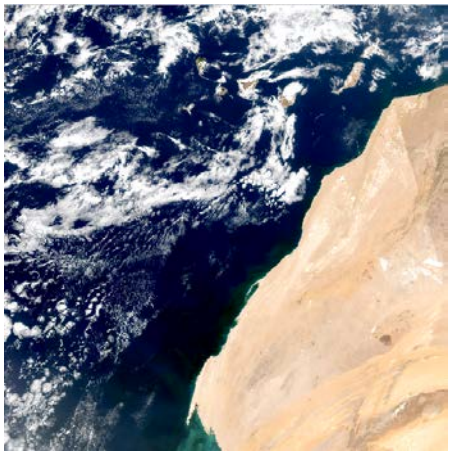
	compact layer _c		integer			
500 m	Surface Reflectance I3 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	Orbit and Coverage *compact layer _c (see* **Table 23***)*	Bit Field	8-bit unsigned integer	15	0 - 255	NA
	Number of additional observa-tions per row	None	32-bit signed integer	-1	0-2147483647	NA

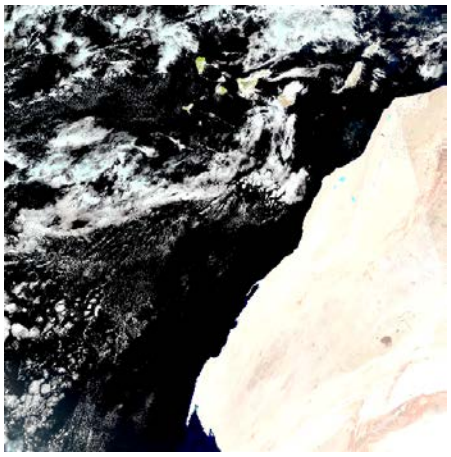
3.2. Description of ARCHIVED Science Data Sets

3.2.1. VNP09GA

VIIRS/NPP Surface Reflectance Daily L2GD 500 m and 1 km (hdf 5 format)

Product description: VNP09GA provides VIIRS/NPP bands M1-5, M7-8 and M10-11 daily surface reflectance at 1 km resolution and band I1, I2 and I3 at 500 m observation and geolocation statistics. Here, observations are determined based on quality and observation coverage. Criteria are the sames as for n-day composite. Best quality is in the first layer.





Figures 7. A VIIRS VNP09GA product composed of surface reflectance data measured by bands M3, M4 and M5 (Top) and I1, I2 and I3 (Bottom) on October 10th 2015 over the West Africa coast. Granule ID:

VNP09GA.A2015283.h16v06.001.2016208151150.h5

Table 6. *Science Data Sets for VNP09GA*

Data Group	Science Data Sets (HDF Layers (58))	Units	Data Type	Fill Value	Valid Range	Scale Factor
1 km	Sensor Azimuth Angle *first layer _1*	Degree	16-bit signed integer	-32767	-18000 - 18000	0.01
1 km	Sensor Zenith Angle *first layer _1*	Degree	16-bit signed integer	-32767	0 - 18000	0.01
1 km	Solar Azimuth Angle *first layer _1*	Degree	16-bit signed integer	-32767	-18000 - 18000	0.01
1 km	Solar Zenith Angle *first layer _1*	Degree	16-bit signed integer	-32767	0 - 18000	0.01
1 km	Surface Reflectance M10 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M11 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M1 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001

1 km	Surface Reflectance M2 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M3 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M4 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M5 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M7 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M8 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance Quality Flags 1 *first layer _1 (see* **Table 10***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 2 *first layer _1 (see* **Table 11***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 3 *first layer _1 (see* **Table 12***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 4 *first layer _1 (see* **Table 13***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 5 *first layer _1 (see* **Table 14***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 6 *first layer _1 (see* **Table 15***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 7 *first layer _1 (see* **Table 16***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Number of Observations 1 km *first layer _1*	None	8-bit unsigned integer	255	0 - 254	NA
1 km	Observations coverage 1km *first layer _1*	Percent	8-bit signed integer	-1	0 - 100	0.01
1 km	Orbit Pointer *first layer _1*	None	8-bit signed integer	-1	0 - 15	NA
500 m	500m Surface Reflectance I1 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
500 m	500m Surface Reflectance I2 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
500 m	500m Surface Reflectance I3 *first layer _1*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
	Obs number of the corresponding obs at the coarser resolution	None	8-bit unsigned integer	255	0 - 254	NA

	first layer _1					
500 m	Number of Observations 500 m	None	8-bit signed integer	-1	0 - 127	NA
500 m	Observation coverage 500m *first layer _1*	Percent	8-bit signed integer	-1	0 - 100	0.01
1 km	Sensor Azimuth Angle *compact layer _c*	Degree	16-bit signed integer	-32767	-18000 - 18000	0.01
1 km	Sensor Zenith Angle *compact layer _c*	Degree	16-bit signed integer	-32767	0 - 18000	0.01
1 km	Solar Azimuth Angle compact layer _c	Degree	16-bit signed integer	-32767	-18000 - 18000	0.01
1 km	Solar Zenith Angle *compact layer _c*	Degree	16-bit signed integer	-32767	0 - 18000	0.01
500 m	500m Surface Reflectance I1 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
500 m	500m Surface Reflectance I2 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
500 m	500m Surface Reflectance I3 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M10 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M11 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M1 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M2 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M3 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M4 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M5 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M7 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance M8 *compact layer _c*	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
1 km	Surface Reflectance Quality Flags 1 *(see* **Table 10***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 2 - *compact layer _c* *(see* **Table 11***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 3 - *compact layer _c* *(see* **Table 12***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA

1 km	Surface Reflectance Quality Flags 4 - *compact layer _c* *(see* **Table 13***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 5 - *compact layer _c* *(see* **Table 14***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 6 - *compact layer _c* *(see* **Table 15***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
1 km	Surface Reflectance Quality Flags 7 - *compact layer _c* *(see* **Table 16***)*	Bit Field	8-bit unsigned integer	255	0 - 255	NA
	Obs number of the correspond-ing obs at the coarser resolution *compact layer _1*	None	8-bit unsigned integer	255	0 - 254	NA
1 km	Number of additional observa-tion in a row 1km	None	32-bit signed integer	-1	0-2147483647	NA
500 m	Number of additional observa-tion in a row 500 m	None	32-bit signed integer	-1	0-2147483647	NA
1 km	Observations coverage 1km *compact layer _c*	Percent	8-bit signed integer	-1	0 - 100	0.01
500 m	Observation coverage 500m *compact layer _c*	Percent	8-bit signed integer	-1	0 - 100	0.01
1 km	Orbit Pointer *compact layer _c*	None	8-bit signed integer	-1	0 - 15	NA

Description of Metadata: Example of VNP09GA.A2016272.h12v04.001.2016273102910.h5

AdditionalLayers1KM = 3
AdditionalLayers500M = 1
AutomaticQualityFlagExplanation = No automatic quality assessment is performed in the PGE
CharacteristicBinAngularSize1KM = 30.0
CharacteristicBinAngularSize500M = 15.0
CharacteristicBinSize1KM = 926.6254330555555
CharacteristicBinSize500M = 463.31271652777775
CoverageCalculationMethod = volume
CoverageMinimum = 0.009999999776482582
DataColumns1KM = 1200
DataColumns500M = 2400
DataRows1KM = 1200
DataRows500M = 2400
DayNightFlag = Day
DeepOceanFlag = Yes
EastBoundingCoord = -65.259486
EndTime = 2016-09-28 23:59:00
FirstLayerSelectionCriteria = order of input pointer
GRingLatitude = 39.785788,49.997192,50.075418,39.841128
GRingLongitude = -78.208333,-93.382166,-77.750568,-65.078078
GeoAnyAbnormal = False
GeoEstMaxRMSError = 0.0
GlobalGridColumns1KM = 43200

GlobalGridColumns500M = 86400
GlobalGridRows1KM = 21600
GlobalGridRows500M = 43200
GranuleBeginningDateTime = 2016-09-28 15:42:00.000,2016-09-28 17:18:00.000,2016-09-28 17:24:00.000,2016-09-28 19:00:00.000,2016-09-28 19:06:00.000
GranuleDayNightFlag = Day
GranuleDayOfYear = 272
GranuleEndingDateTime = 2016-09-28 15:48:00.000,2016-09-28 17:24:00.000,2016-09-28 17:30:00.000,2016-09-28 19:06:00.000,2016-09-28 19:12:00.000
GranulePointerArray = -1
HorizontalTileNumber = 12
InputPointer =
/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1542.001.2016273003716.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1718.001.2016273011108.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1724.001.2016273011110.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1900.001.2016273024342.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1906.001.2016273024347.hdf,/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1542.001.2016273003716.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1718.001.2016273011108.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1724.001.2016273011110.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1900.001.2016273024342.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/NPP_IMFTS_L1.A2016272.1906.001.2016273024347.hdf,/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNPPT1KDI.A2016272.h12v04.001.2016273102243.hdf,/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1542.001.2016273015144.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1718.001.2016273031919.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1724.001.2016273031431.hdf:/MODAP-
Sops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1900.001.2016273035243.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1906.001.2016273035616.hdf,/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNPPTHKDI.A2016272.h12v04.001.2016273102243.hdf,/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1542.001.2016273015144.hdf:/MODAPSops4/archive/f5828/run-
ning/VNP_L5mc/1632175542/VNP09.A2016272.1718.001.2016273031919.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1724.001.2016273031431.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1900.001.2016273035243.hdf:/MODAPSops4/archive/f5828/running/VNP_L5mc/1632175542/VNP09.A2016272.1906.001.2016273035616.hdf
KeepAll = No
L2GStorageFormat1KM = compact
L2GStorageFormat500M = compact
LocalGranuleID = VNP09GA.A2016272.h12v04.001.2016273102910.h5
LocalVersionID = 2.1.0
LongName = VIIRS/NPP Surface Reflectance Daily L2G Global 1km and 500m SIN Grid
MaxOutputRes = HKM
MaximumObservations1KM = 4
MaximumObservations500M = 2
NadirDataResolution1KM = 1km
NadirDataResolution500M = 500m
NorthBoundingCoord = 50.0
NumberLandWater1KM = 21779
NumberLandWater500M = 43558
NumberOfOrbits = 2
NumberofInputGranules = 5
NumberofOverlapGranules = 4
OrbitNumber.1 = 25500
OrbitNumber.2 = 25501
OrbitNumberArray = -1
PGEVersion = 1.0.4
PGE_EndTime = 2016-09-29 00:00:00.000
PGE_StartTime = 2016-09-28 00:00:00.000

ParameterName = VNP09G
PercentCloudy = 50
PercentLand = 63
PercentLandSeaMaskClass = 0
PercentLowSun = 0
PercentProcessed = 100
PercentShadow = 0
ProcessingEnvironment = Linux minion5828 2.6.18-412.el5 #1 SMP Mon Sep 5 23:11:58 UTC 2016 x86_64 x86_64 x86_64 GNU/Linux
ProductionTime = 2016-09-29 10:29:10.000
QAPercentGoodQuality = 100
QAPercentInterpolatedData = 0
QAPercentMissingData = 0
QAPercentNotProducedCloud = 0
QAPercentNotProducedOther = 0
QAPercentOtherQuality = 0
QAPercentOutOfBoundsdata = 0
RangeBeginningDate = 2016-09-28
RangeBeginningTime = 17:18:00.000
RangeEndingDate = 2016-09-28
RangeEndingTime = 19:12:00.000
Ranking = No
ReprocessingActual = metadata field
ReprocessingPlanned = metadata field
ScienceQualityFlagExplanation = unknown
ShortName = VNP09GA
SouthBoundingCoord = 40.0
StartTime = 2016-09-28 00:00:00
SystemFileName = VNPPT1KDI.A2016272.h12v04.001.2016273102243.hdf,VNPPTHKDI.A2016272.h12v04.001.2016273102243.hdf,VNPMGGAD1I.A2016272.h12v04.001.2016273102243.hdf,VNP09G1KI.A2016272.h12v04.001.2016273102706.hdf,VNP09GHKI.A2016272.h12v04.001.2016273102706.hdf
TileID = 51012004
TotalAdditionalObservations1KM = 1353461
TotalAdditionalObservations500M = 4231446
TotalObservations1KM = 2793461
TotalObservations500M = 9991446
VersionID = 001
VerticalTileNumber = 4
WestBoundingCoord = -93.34343
ZoneIdentifier = 0
identifier_product_doi = 10.5067/VIIRS/VNP09GA.001
identifier_product_doi_authority = http://dx.doi.org
l2gl_storage_format_1km = compact
l2gl_storage_format_500m = compact
maximum_observations_1km = 4
maximum_observations_500m = 2
total_additional_observations_1km = 1353461
total_additional_observations_500m = 4231446

3.2.2. VNP09A1

NPP/VIIRS Surface Reflectance Daily L3 1km SIN Grid Deg CMG (hdf 5 format)

Product description: VNP09A1 provides VIIRS/NPP band M1-M5, M7-8, M110-11 surface reflectance at 1km resolution. It is a level-3 composite of 1 km resolution VNP09G1KI. Each product pixel contains the best possible L2G observation during an 8-day period as selected on the basis of high observation coverage, low sensor angle, absence of clouds or cloud shadow, and aerosol loading.

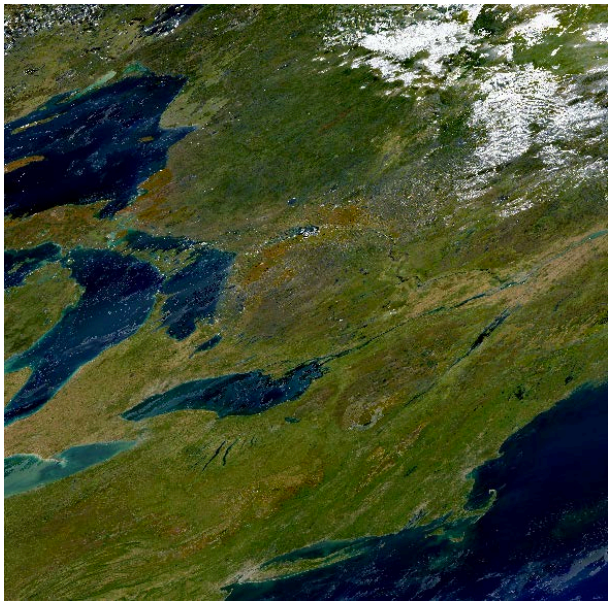


Figure 8. RGB VNP09A1 product composed of surface reflectance data measured by bands I1, I2 and I3 on October 8th, 2015 over the Eastern America. Granule ID is VNP09A1.A2015281.h12v04.001.2016210051812.h5

Table 7. *Science Data Sets for VNP09A1.*

Science Data Sets (HDF Layers (15))	Units	Data Type	Fill Value	Valid Range	Scale Factor
Relative Azimuth Angle	Degree	16-bit signed integer	0	-18000 - 18000	0.01
Sensor Zenith Angle	Degree	16-bit signed integer	0	0 - 18000	0.01
Solar Zenith Angle	Degree	16-bit signed integer	0	0 - 18000	0.01
Surface Reflect. Day of Year	Julian day	16-bit unsigned integer	65535	1 - 366	NA
Surface Reflectance M1	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance M10	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance M11	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance M2	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance M3	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance M4	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance M5	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance M7	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance M8	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band QC (*see* **Table 18**)	Bit Field	32-bit unsigned integer	1073741824	NA	NA
Surface Reflectance State QA (*see* **Table 19**)	Bit field	16-bit signed integer	65535	NA	NA

Description of Metadata: Example of VNP09A1.A2016265.h11v04.001.2016273101946.h5

AlgorithmType = OPS
DataResolution = Moderate
DayNumbers = 265,266,267,268,269,270,271,272
EastBoundingCoord = -78.31356
EndTime = 2016-09-29 00:00:00
GRingLatitude = 39.772839,49.986346,50.092114,39.848925
GRingLongitude = -91.338797,-109.08551,-93.396817,-78.149657
HorizontalTileNumber = 11
InputPointer =
/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016265.h11v04.001.2016267152453.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016266.h11v04.001.2016267173731.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016267.h11v04.001.2016268115943.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016268.h11v04.001.2016269111839.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016269.h11v04.001.2016270102923.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016270.h11v04.001.2016271095546.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016271.h11v04.001.2016272110756.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016272.h11v04.001.2016273101153.h5
LSIPS_AlgorithmVersion = NPP_PR09A 1.0.2
LocalGranuleID = VNP09A1.A2016265.h11v04.001.2016273101946.h5
LongName = VIIRS/NPP Surface Reflectance 8-Day L3 Global 1km SIN Grid
NorthBoundingCoord = 50.0
PGENumber = 521
PGEVersion = 1.0.4
PGE_EndTime = 2016-09-29 00:00:00.000
PGE_StartTime = 2016-09-21 00:00:00.000
PlatformShortName = NPP
ProcessVersion = 001
ProcessingCenter = MODAPS, NASA GSFC
ProcessingEnvironment = Linux minion5832 2.6.18-410.el5 #1 SMP Wed May 11 06:00:14 EDT 2016 x86_64 x86_64 x86_64 GNU/Linux
Product_authority = http://dx.doi.org
Product_doi = 10.5067/VIIRS/VNP09A1.001
ProductionTime = 2016-09-29 10:19:46.000
RangeBeginningDate = 2016-09-21
RangeBeginningTime = 00:00:00.000
RangeEndingDate = 2016-09-29
RangeEndingTime = 00:00:00.000
SatelliteInstrument = NPP_OPS
SensorShortname = VIIRS
ShortName = VNP09A1
SouthBoundingCoord = 40.0
StartTime = 2016-09-21 00:00:00
TileID = 51011004
VerticalTileNumber = 04
WestBoundingCoord = -108.90067

3.2.3. VNP09H1

NPP/VIIRS Surface Reflectance 8-Day L3 Global 500 m (hdf 5 format)

Product description: VNP09H1 provides VIIRS band I1-I3 surface reflectance at 500 m resolution. It is a level 3 composite of VNP09GHKI. Each pixel contains the best possible L2G observation during an 8-day period as selected on the basis of high observation coverage, low sensor angle, the absence of clouds or cloud shadow, and aerosol loading.

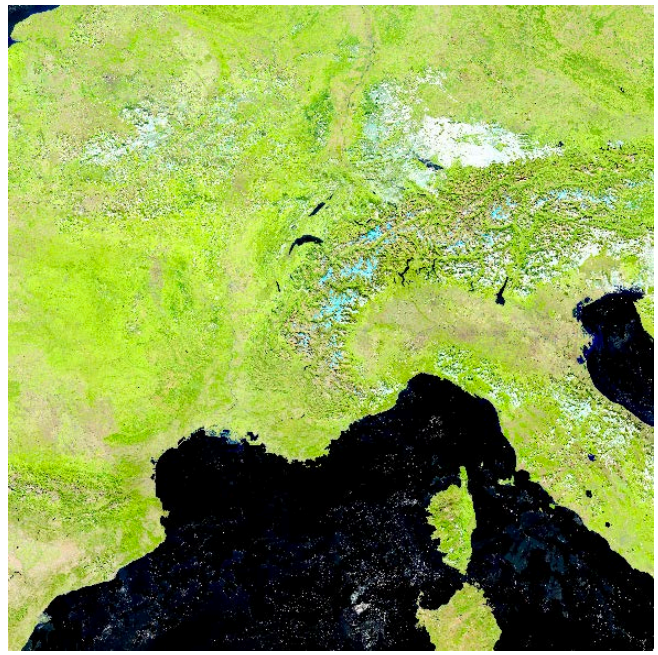


Figure 9. RGB VNP09H1 product composed of surface reflectance data measured by bands I1, I2 and I3 on October 8th, 2015 over the South of France. Part of the Granule ID : VNP09H1.A2015281.h18v04.001.2016210053534.h5

Table 8. *Science Data Sets for VNP09H1*

Science Data Sets (HDF Layers (5))	Units	Data Type	Fill Value	Valid Range	Scale Factor
Surface Reflectance Band I1	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band I2	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band I3	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band QC (*see* **Table 17**)	Bit Field	16-bit unsigned integer	65535	0 - 32767	NA
Surface Reflectance State QA (*see* **Table 19**)	Bit Field	16-bit unsigned integer	65535	NA	NA

Description of Metadata: Example of VNP09H1.A2016265.h11v04.001.2016273101946.h5

AlgorithmType = OPS
DataResolution = Imagery
DayNumbers = 265,266,267,268,269,270,271,272
EastBoundingCoord = -78.31356
EndTime = 2016-09-29 00:00:00
GRingLatitude = 39.772839,49.986346,50.092114,39.848925
GRingLongitude = -91.338797,-109.08551,-93.396817,-78.149657
HorizontalTileNumber = 11
InputPointer =
/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016265.h11v04.001.2016267152453.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016266.h11v04.001.2016267173731.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016267.h11v04.001.2016268115943.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016268.h11v04.001.2016269111839.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016269.h11v04.001.2016270102923.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016270.h11v04.001.2016271095546.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016271.h11v04.001.2016272110756.h5,/MODAPSops4/archive/f5832/running/VNP_L10mc/1632177053/VNP09GA.A2016272.h11v04.001.2016273101153.h5
LSIPS_AlgorithmVersion = NPP_PR09A 1.0.2
LocalGranuleID = VNP09H1.A2016265.h11v04.001.2016273101946.h5
LongName = VIIRS/NPP Surface Reflectance 8-Day L3 Global 500m SIN Grid
NorthBoundingCoord = 50.0
PGENumber = 521
PGEVersion = 1.0.4
PGE_EndTime = 2016-09-29 00:00:00.000
PGE_StartTime = 2016-09-21 00:00:00.000
PlatformShortName = NPP
ProcessVersion = 001
ProcessingCenter = MODAPS, NASA GSFC
ProcessingEnvironment = Linux minion5832 2.6.18-410.el5 #1 SMP Wed May 11 06:00:14 EDT 2016 x86_64 x86_64 x86_64 GNU/Linux
Product_authority = http://dx.doi.org
Product_doi = 10.5067/VIIRS/VNP09H1.001
ProductionTime = 2016-09-29 10:19:46.000
RangeBeginningDate = 2016-09-21
RangeBeginningTime = 00:00:00.000
RangeEndingDate = 2016-09-29
RangeEndingTime = 00:00:00.000
SatelliteInstrument = NPP_OPS
SensorShortname = VIIRS
ShortName = VNP09H1
SouthBoundingCoord = 40.0
StartTime = 2016-09-21 00:00:00
TileID = 51011004
VerticalTileNumber = 04
WestBoundingCoord = -108.90067

3.2.4. VNP09CMG

NPP/VIIRS Surface Reflectance Daily L3 Global DDR 0.05 Deg CMG (hdf 5 format)

Product description: VNP09CMG provides VIIRS bands M1-M5, M7-M8, M10-11 and I1-I3 surface reflectance at 0.05-degree resolution. This product is based on a Climate Modeling Grid (CMG) for the purpose of being used in climate simulation models. We use a weighted average of the best quality observation form the Level 2 product.

Figure 10. A VNP09CMG RGB-image composed of surface reflectance from bands M3 (Blue), M4 (Green) and M5 (Red) on August 5, 2015. Product granule ID: VNP09CMG.A2015217.001.2016199113723.h5

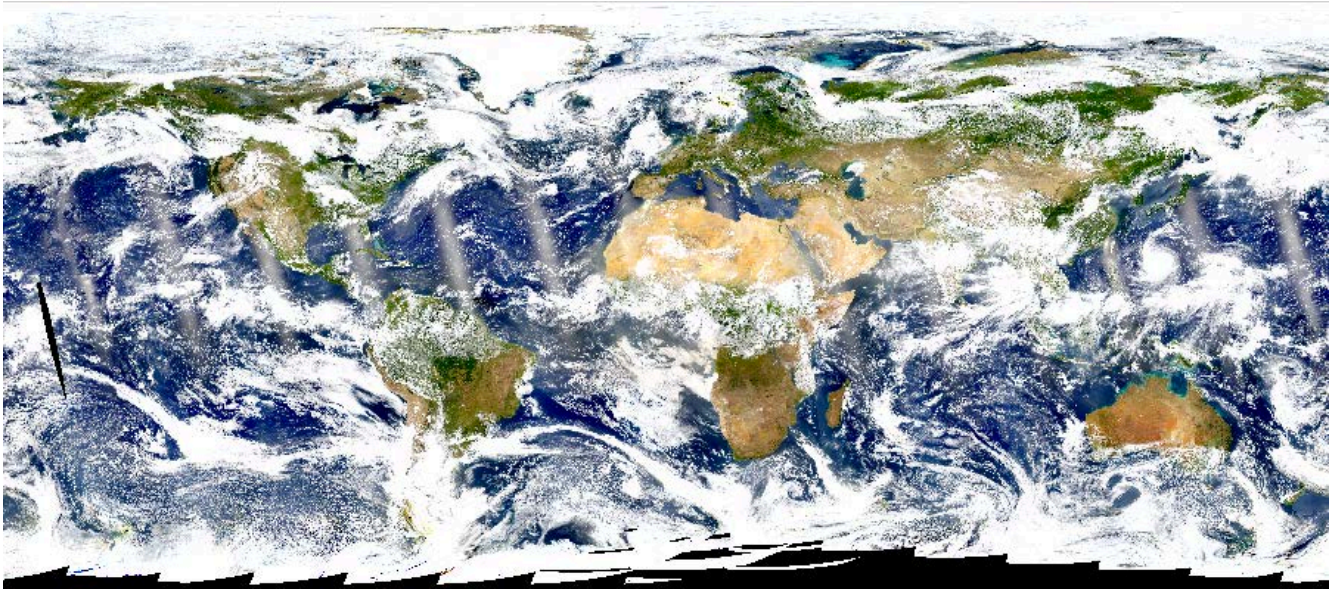


Figure 11. A VNP09CMG image composed of surface reflectance from bands I1 (Near Infrared) and I2 (Red) on August 5, 2015. Product granule ID: VNP09CMG.A2015217.001.2016199113723.h5

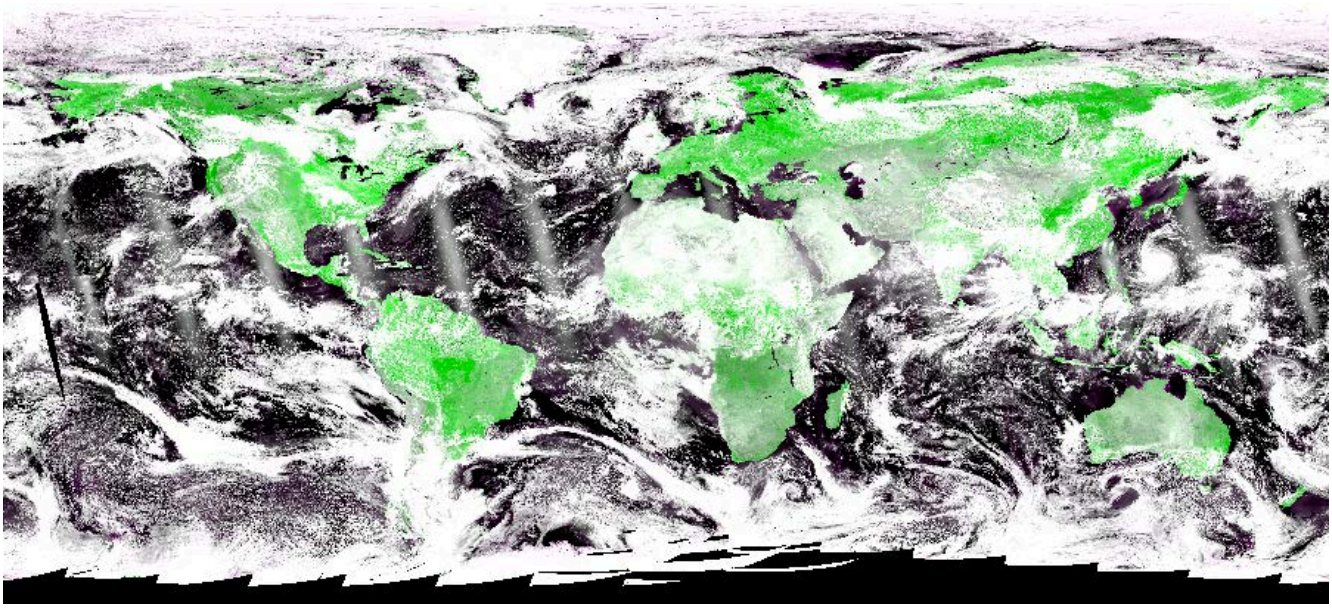


Table 9. *Science Data Sets for VNP09CMG.*

Science Data Sets (HDF Layers (33))	Units	Data Type	Fill Value	Valid Range	Scale Factor
Brightness Temperature Band M12	Degrees K	16-bit unsigned integer	0	0 - 40000	0.01
Brightness Temperature Band M13	Degrees K	16-bit unsigned integer	0	0 - 40000	0.01
Brightness Temperature Band M14	Degrees K	16-bit unsigned integer	0	0 - 40000	0.01
Brightness Temperature Band M15	Degrees K	16-bit unsigned integer	0	0 - 40000	0.01
Brightness Temperature Band M16	Degrees K	16-bit unsigned integer	0	0 - 40000	0.01
Granule Time	HHMM	16-bit signed integer	0	0 - 2355	1
Number 375 m pixels averaged	None	16-bit unsigned integer	0	1 - 200	NA
Number 750 m pixels averaged	None	16-bit unsigned integer	0	1 - 40	NA
Number Mapping 1 *(see* **Table 22***)*	None	32-bit unsigned integer	0	0-2097151	NA
Number Mapping 2 *(see* **Table 23***)*	None	32-bit unsigned integer	0	0-2097151	NA
Relative Azimuth Angle	Degree	16-bit signed integer	0	-18000 - 18000	0.01
Sensor Zenith Angle	Degree	16-bit signed integer	0	0 - 18000	0.01
Solar Zenith Angle	Degree	16-bit signed integer	0	0 - 18000	0.01
CMG Surface Reflectance State QA (*see* **Table 20**)	Bit Field	16-bit signed integer	0	1 - 65535	NA
Surface Reflectance Band I1	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band I2	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band I3	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M1	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M10	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M11	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M2	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M3	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M4	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M5	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M7	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001
Surface Reflectance Band M8	Reflectance	16-bit signed integer	-28672	-100 - 16000	0.0001

Surface Reflectance Quality Flags 1 *(see* **Table 10***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
Surface Reflectance Quality Flags 2 *(see* **Table 11***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
Surface Reflectance Quality Flags 3 *(see* **Table 12***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
Surface Reflectance Quality Flags 4 *(see* **Table 13***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
Surface Reflectance Quality Flags 5 *(see* **Table 14***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA
Surface Reflectance Quality Flags 6 *(see* **Table 15***)*	Bit field	8-bit unsigned integer	255	0 - 255	NA

Description of Metadata: Example of VNP09H1.A2016265.h11v04.001.2016273101946.h5

AlgorithmType = NPP_OPS
DataResolution = 5km
DayNightFlag = Day
EastBoundingCoord = 180.0
EndTime = 2016-09-29 00:00:00
InputPointer =
VNP09.A2016272.0000.001.2016272090319.hdf,…,VNPAMI_L2.A2016272.0000.001.2016272085614.hdf,…,VNP04_L2.A2016272.0000.001.2016272085614.hdf,…,NPP_VMAES_L1.A2016272.0000.001.2016272080247.hdf,…
LSIPS_AlgorithmVersion = NPP_PRCMGDaily 1.0.0
LocalGranuleID = VNP09CMG.A2016272.001.2016273105922.h5
LongName = VIIRS/NPP Surface Reflectance Daily L3 Global 0.05 Deg CMG
NorthBoundingCoord = 90.0
NumberofInputGranules = 144
PGENumber = 575
PGEVersion = 1.0.5
PGE_EndTime = 2016-09-29 00:00:00.000
PGE_Name = PGE575
PGE_StartTime = 2016-09-28 00:00:00.000
PlatformShortName = NPP
ProcessVersion = 001
ProcessingEnvironment = Linux minion5835 2.6.18-410.el5 #1 SMP Wed May 11 06:00:14 EDT 2016 x86_64 x86_64 x86_64 GNU/Linux
ProductionTime = 2016-09-29 10:59:22.000
RangeBeginningDate = 2016-09-28
RangeBeginningTime = 00:00:00.000000
RangeEndingDate = 2016-09-29
RangeEndingTime = 00:00:00.000000
SatelliteInstrument = NPP_OPS
SensorShortname = VIIRS
ShortName = VNP09CMG
SouthBoundingCoord = -90.0
StartTime = 2016-09-28 00:00:00
WestBoundingCoord = -180.0
identifier_product_doi = 10.5067/VIIRS/VNP09CMG.001
identifier_product_doi_authority = http://dx.doi.org

3.3. Data product quality & state QA flags

Table 10. *Surface Reflectance Quality Flags* ***QF1*** *(8-bit). Note that bit 0 is the Least Significant Bit (LSB).*

Bit No.	Parameter Name	Bit Comb.	
0-1	Cloud mask quality	00	Poor
		01	Low
		10	Medium
		11	High
2-3	Cloud detection & confidence	00	Confident clear
		01	Probably clear
		10	Probably cloudy
		11	Confident cloudy
4	Day/Night	0	Day
		1	Night
5	Low sun mask	0	High
		1	Low
6-7	Sun Glint	00	None
		01	Geometry based
		10	Wind speed based
		11	Geometry and wind speed based

Table 11. *Surface Reflectance Quality Flags* ***QF2*** *(8-bit). Note that bit 0 is the Least Significant Bit (LSB).*

Bit No.	Parameter Name	Bit Comb.	
0-2	Land/Water background	000	Land & desert
		001	Land no desert
		010	Inland water
		011	Sea Water
		100	---
		101	Coastal
		110	---
3	Shadow Mask	0	No cloud shadow
		1	Shadow

4	Heavy aerosol mask	0	No heavy aerosol
		1	Heavy aerosol
5	Snow/ice	0	No snow/ice
		1	Snow or Ice
6	Thin cirrus reflective	0	No cloud
		1	Cloud
7	Thin cirrus emissive	0	No cloud
		1	Cloud

Table 12. *Surface Reflectance Quality Flags **QF3** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).*

Bit No.	Parameter Name	Bit Comb.	
0	Bad M1 SDR data	0	No
		1	Yes
1	Bad M2 SDR data	0	No
		1	Yes
2	Bad M3 SDR data	0	No
		1	Yes
3	Bad M4 SDR data	0	No
		1	Yes
4	Bad M5 SDR data	0	No
		1	Yes
5	Bad M7 SDR data	0	No
		1	Yes
6	Bad M8 SDR data	0	No
		1	Yes
7	Bad M10 SDR data	0	No
		1	Yes

Table 13. *Surface Reflectance Quality Flags **QF4** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).*

Bit No.	Parameter Name	Bit Comb.	
0	Bad M11 SDR data	0	No
		1	Yes
1	Bad I1 SDR data	0	No
		1	Yes
2	Bad I2 SDR data	0	No
		1	Yes
3	Bad I3 SDR data	0	No
		1	Yes
4	Overall quality of AOT	0	Good
		1	Bad
5	Missing AOT input data	0	No
		1	Yes
6	Invalid land AM input data	0	Valid
		1	Invalid AM Input over Land or over Ocean
7	Missing PW input data	0	No
		1	Yes

Table 14. *Surface Reflectance Quality Flags **QF5** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).*

Bit No.	Parameter Name	Bit Comb.	
0	Missing Ozone input data	0	No
		1	Yes
1	Missing Surface Pressure input data	0	No
		1	Yes
2	Overall quality M1 Surf. Refl. data	0	Good
		1	Bad
3	Overall quality M2 Surf. Refl. data	0	Good
		1	Bad
4	Overall quality M3 Surf. Refl. data	0	Good
		1	Bad

5	Overall quality M4 Surf. Refl. data	0	Good
		1	Bad
6	Overall quality M5 Surf. Refl. data	0	Good
		1	Bad
7	Overall quality M7 Surf. Refl. data	0	Good
		1	Bad

Table 15. *Surface Reflectance Quality Flags **QF6** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).*

Bit No.	Parameter Name	Bit Comb.	
0	Overall quality M8 Surf. Refl. data	0	No
		1	Yes
1	Overall quality M10 Surf. Refl. data	0	No
		1	Yes
2	Overall quality M11 Surf. Refl. data	0	Good
		1	Bad
3	Overall quality I1 Surf. Refl. data	0	Good
		1	Bad
4	Overall quality I2 Surf. Refl. data	0	Good
		1	Bad
5	Overall quality I3 Surf. Refl. data	0	Good
		1	Bad
6	Unused	-	---
7	Unused	-	---

Table 16. *Surface Reflectance Quality Flags **QF7** (8-bit). Note that bit 0 is the Least Significant Bit (LSB).*

Bit No.	Parameter Name	Bit Comb.	
0	Snow present	0	No
		1	Yes
1	Adjacent to cloud	0	No
		1	Yes
2-3	Aerosol quantity	00	Climatology
		01	Low
		10	Average
		11	High
4	Thin Cirrus Flag	0	No
		1	Yes
5	Unused	-	---
6	Unused	-	---
7	Unused	-	---

Table 17. *Surface Reflectance Band Quality Control Description (16-bit). Bit 0 is LSB.*

Used for VNP09HI (500 m)

Bit No.	Parameter Name	Bit Comb.	
0-1	MODLAND QA bits	00	Corrected product produced at ideal quality all bands
		01	Corrected product produced at less than ideal quality some or all bands
		10	Corrected product not produced due to cloud effects all bands
		11	Corrected product not produced due to other reasons some or all bands may be fill value [Note that a value of (11) overrides a value of (01)].
2-3	Cloud State	00	Clear
		01	Cloudy
		10	Mixed
		11	Not set, assumed clear
4-7	Band 1 data quality four bit range	0000	Highest quality
		0111	Noisy detector
		1000	Dead detector, data interpolated in L1B
		1001	Solar zenith >= 86 degrees
		1010	Solar zenith >= 85 and < 86 degrees
		1011	Missing input
		1100	Internal constant used in place of climatological data for at least one atmospheric constant
		1101	Correction out of bounds, pixel constrained to extreme allow-able value
		1110	L1B data faulty
		1111	Not processed due to deep ocean or clouds
8-11	Band 2 data quality four bit range		SAME AS BAND 1 ABOVE
12	Atmospheric correction performed	1	Yes
		0	No
13	Adjacency correction performed	1	Yes
		0	No
14	Different orbit from 500 m	1	Yes
		0	No
15	Spare (unused)	-	---

Table 18. *Surface Reflectance Band Quality Control Description (32-bit). Bit 0 is LSB.*

Used for VNP09AI (1 km)

Bit No.	Parameter Name	Bit Comb.	
0-1	MODLAND QA bits	00	corrected product produced at ideal quality -- all bands
		01	corrected product produced at less than ideal quality -- some or all bands
		10	corrected product not produced due to cloud effects -- all bands
		11	corrected product not produced for other reasons -- some or all bands, may be fill value (11) [Note that a value of (11) overrides a value of (01)].
2-5	Band 1 data quality, four bit range	0000	highest quality
		0111	noisy detector
		1000	dead detector, data interpolated in L1B
		1001	solar zenith >= 86 degrees
		1010	solar zenith >= 85 and < 86 degrees
		1011	missing input
		1100	internal constant used in place of climatological data for at least one atmospheric constant
		1101	correction out of bounds, pixel constrained to extreme allowable value
		1110	L1B data faulty
		1111	not processed due to deep ocean or clouds
6-9	Band 2 data quality four bit range		same as band above
10-13	Band 3 data quality four bit range		same as band above
14-17	Band 4 data quality four bit range		same as band above
18-21	Band 5 data quality four bit range		same as band above
22-25	Band 6 data quality four bit range		same as band above
26-29	Band 7 data quality four bit range		same as band above
30	Atmospheric correction performed	1	yes
		0	no
31	Adjacency correction performed	1	yes
		0	no

Table 19. *Surface Reflectance State QA description (16-bit). Bit 0 is LSB.*

Used for VNP09AI (1 km) and VNP09HI (500 m)

Bit No.	Parameter Name	Bit Comb.	
0-1	Cloud state	00	clear
		01	cloudy
		10	mixed
		11	not set, assumed clear
2	Cloud shadow	1	yes
		0	no
3-5	Land/water flag	000	shallow ocean
		001	land
		010	ocean coastlines and lake shorelines
		011	shallow inland water
		100	ephemeral water
		101	deep inland water
		110	continental/moderate ocean
		111	deep ocean
6-7	Aerosol quantity	00	climatology
		01	low
		10	average
		11	high
8-9	Cirrus detected	00	none
		01	small
		10	average
		11	high
10	Internal cloud algorithm flag	1	cloud
		0	no cloud
11	Internal fire algorithm flag	1	fire
		0	no fire
12	Snow/ice flag	1	yes
		0	no
13	Pixel is adjacent to cloud	1	yes
		0	no
14	BRDF correction performed	1	yes
		0	no
15	Internal snow flag	1	snow
		0	no snow

Table 20. *Surface Reflectance CMG State QA description (16-bit). Bit 0 is LSB.*

Used for VNP09CMG

Bit No.	Parameter Name	Bit Comb.	
0-1	Cloud state	00	Confident clear
		01	Probably clear
		10	Probably Cloudy
		11	Confident cloudy
2	Cloud shadow	1	Yes
		0	No
3-5	Land/water flag	000	Land & desert
		001	Land no desert
		010	Inland water
		011	Sea Water
		100	---
		101	Coastal
		110	---
		111	---
6	Overall aerosol quantity	0	No
		1	OK
7	Unused	-	---
8	Thin cirrus reflective	1	Yes
		0	No
9	Thin cirrus emissive	1	Yes
		0	No
10	Cloud flag	1	Cloud
		0	No cloud
11-14	Unused	-	---
15	Snow/Ice flag	1	Snow/Ice
		0	No Snow/Ice

3.4. Number Mapping

Table 21. CMG Number Mapping (32-bit). Bit 0 is LSB.

Used for VNP09CMG

Bit No.	Description
0-15	Number of pixel mapping flagged as adjacent to cloud
16-31	Number of pixel mapping flagged for snow

Table 22. CMG Number Mapping (32-bit). Bit 0 is LSB.

Used for VNP09CMG

Bit No.	Description
0-15	Number of pixel mapping flagged as cloudy
16-31	Number of pixel mapping flagged as cloud shadow

3.5. Orbit and coverage

Table 23. *Orbit and coverage data set (8-bit). Bit 0 is LSB.*

Used for VNP09G1KI and VNP09GHKI

Bit No.	Parameter Name	Bit Comb.	orb_cov_1
0-3	Orbit number	range: from 0 to 13 key: from 0000 (0) to 1011 (13)	
4	Scan half flag	0	top half
		1	bottom half
6-7	Land/water flag	000	0.0 – 12.5%
		001	12.5 – 25.0%
		010	25.0 – 37.5%
		011	37.5 – 50.0%
		100	50.0 – 62.5%
		101	62.5 – 75.0%
		110	75.0 – 87.5%
		111	87.5 – 100.0%

4. Caveats and Known Problems

The performance of the atmospheric correction algorithm degrades as the view and solar zenith angles get larger and as aerosol optical thickness gets larger; the algorithm is also less accurate for bands at shorter wavelengths. The level of accuracy of the atmospheric correction is typically

$$\pm(0.005 + 0.05*\text{reflectance})$$

under favorable conditions (not high aerosol). The look-up tables used in the atmospheric correction algorithm also assume upper limits of 5.0 for aerosol optical thickness and 75° for solar zenith angles.

5. Data ordering (& browsing)

5.1. Where can I browse data

All of the file types listed as available in Table 2 are available as browse at the following website:

VIIRS Land Global Browse Images

Link: http://landweb.nascom.nasa.gov/cgi-bin/NPP/browse/NPPbrowse.cgi

5.2. Where to get data from

All of the file types listed as available in Table 2 are available by ftp at the following websites

LP_DAAC: Land Process Distributed Active Archive Center (//https://lpdaac.usgs.gov)

VNP09GA – daily L2G-lite Surface Reflectance (500m and 1km)
VNP09CMG – daily surface reflectance CMG
VNP09H1 – 8-day composite Reflectance 500m
VNP09A1 – 8-day composite Reflectance 1km

LAADS: Level 1 and Atmosphere Archive and Distribution System (//ladsweb.nascom.nasa.gov)
List of products by ESDT to be available to public from LAADS (with approval from LP-DAAC)

VNP09 – daily L2 swath
VNP09GA – daily L2G-lite Surface Reflectance (500m and 1km)
VNP09CMG – daily surface reflectance CMG
VNP09H1 – 8-day composite Reflectance 500m
VNP09A1 – 8-day composite Reflectance 1km

Following L2G products for the latest 40 days are available online from LAADS and any prior days using LAADS-POD (Product On Demand)

VNP09GHKI – Daily L2G Surface Reflectance 500m
VNP09G1KI - Daily L2G Surface Reflectance 1km

5.3. Data product granule ID

All archived data is accessed by its LOCALGRANULEID.

For data in the sinusoidal grid, the LOCALGRANULEID is constructed like this:

Example 1: VNP09GHKI.A2015218.h30v10.001.2016208151150.hdf

VNP09GHKI: product short ESDT[1] name (long name is : VIIRS/NPP Surface Reflectance Daily L2G Global DDR 500 m sin grid day)

A20015218: Acquisition year (2015) and Julian day (218)

h30v10: tile ID (see Figure 2)

001: Re-Processing version number 1 (V1)

2016208151150: Production year (2016), Julian day (208), and time (15:11:50)

hdf: hdf 4 format

For Climate Modeling Grid data (CMGs), the LOCALGRANULEID is constructed like this:

Example 2: VNP09CMG.A2015293.001.2015295042946.h5

VNP09CMG: product short EDST[1] name (long name is : NPP/VIIRS Surface Reflectance Daily L3 Global DDR 0.05 Deg CMG)

A2015293: Acquisition year (2015) and Julian day (293)

001: Re-Processing version number 1 (V1)

2015295042946: Production year (2015), Julian day (295), and time (04:29:46)

h5: hdf 5 format

5.4. Data viewing tools (not inclusive).

a) Imager (platform: Linux)

A software tool specifically designed by the MODIS LSR SCF for viewing surface reflectance suites. *Link:* http://modis-sr.ltdri.org/pages/software.html

b) HDFLook (platforms: SUN, AIX, SGI, Linux, MacOSX, Cygwin)

A multifunctional data processing and visualization tool for land, ocean and atmosphere MODIS data. *Link:* http://www-loa.univ-lille1.fr/Hdflook/hdflook_gb.html

c) ENVI (platforms: Windows & Linux)

Software for the visualization, analysis, and presentation of all types of digital imagery.

Link: http://www.ittvis.com/envi/

d) HDF Explorer (platform: Windows)

A software environment where data are first viewed in a tree-like interface, and then optionally loaded and visualized in a variety of ways. *Link:* http://www.space-research.org/

[1] ESDT: Earth Science Data Type