VIIRS/NPP CGF Snow Cover Daily L3 Global 375m SIN Grid, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Riggs, G. A., D. K. Hall, and M. O. Román. 2019. *VIIRS/NPP CGF Snow Cover Daily L3 Global 375m SIN Grid, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/VIIRS/VNP10A1F.001. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/VNP10A1F

National Snow and Ice Data Center

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1 DATA DESCRIPTION

Snow-covered land typically has very high reflectance in visible bands and very low reflectance in shortwave infrared bands. The Normalized Difference Snow Index (NDSI) reveals the magnitude of this difference. This data set includes NDSI cloud-gap-filled (CGF) snow cover and NDSI snow cover, as well as cloud persistence, quality, and geolocation parameters. Table 1 provides a description of each parameter.

1.1 Parameters

Table 1. Parameter Details

Parameter	Description	Values
`CGF_NDSI_Snow_Cover`	Gridded cloud-gap-filled NDSI snow cover.	NDSI snow cover values and data flag values, stored as 8-bit unsigned integers. 0 - 100: NDSI snow cover (no snow to completely snow covered) 201: no decision 211: night 237: inland water 239: ocean 250: cloud 251: missing data 252: unusable L1B (input) data 253: bowtie trim* 254: L1B (input) fill 255: fill
`Cloud_Persistence`	The number of consecutive days with cloud cover.	Cloud persistence values. 0-254: valid data range 255: fill value

Parameter	Description	Values
VNP10A1_NDSI_Snow_Cover	Gridded NDSI snow cover from VIIRS/NPP Snow Cover Daily L3 Global 375m SIN Grid, Version 1 (VNP10A1).	NDSI snow cover values and data flag values, stored as 8-bit unsigned integers. 0 - 100: NDSI snow cover (no snow to completely snow covered) 201: no decision 211: night 237: inland water 239: ocean 250: cloud 251: missing data 252: unusable L1B (input) data 253: bowtie trim* 254: L1B (input) fill 255: fill
Algorithm_Bit_Flags_QA	Data screens applied to identify false or uncertain snow detections.	Bit flag values 0: Inland water 1: Low visible screen failed, snow detection reversed to no snow 2: Low NDSI screen failed, snow detection reversed to no snow 3: Combined temperature/height screen failed 4: Spare 5: Shortwave IR (SWIR) reflectance anomalously high 6: Spare 7: Uncertain snow detection due to low illumination
Basic_QA	General quality estimate for pixels processed for snow.	Quality assessment flag values 0: good 1: poor 2: bad 3: other 211: night 239: ocean 250: cloud 252: no decision 253: bowtie trim*
Projection	Sinusoidal projection attributes.	N/A

Parameter	Description	Values
XDim	Projected upper left X coordinate for each pixel in km.	Coordinate value range for data set -20015.109354 to 20015.109354
YDim	Projected upper left Y coordinate for each pixel in km.	Coordinate value range for data set -10007.554677 to 10007.554677
*Bowtie trim pixels caused by overlapping instrument scans are removed from the data. However, the bowtie trim attribute remains in the file level metadata to preserve consistency with lower level products.		

1.1.1 Interpreting Algorithm_bit_flags_QA

Pixels determined to have some snow present are subjected to a series of screens to alleviate snow commission errors (false snow detection) and to flag uncertain snow detections. In addition, snow-free pixels are screened for very low illumination conditions to prevent possible snow omission errors. Screen results, as well as the location of inland water, are stored as bit flags in the 'Algorithm_Bit_Flags_QA' field. For a detailed description of the Snow Cover QA flags see the Data Screens section in the VIIRS Snow Products User Guide (Riggs et al. 2019).

To identify bit flag values, convert the decimal grid cell value to its binary equivalent. Bit values default to 0 and are set to 1 if the screen result is true. An example of the bit flag format for the decimal value '129' is provided in Figure 1.

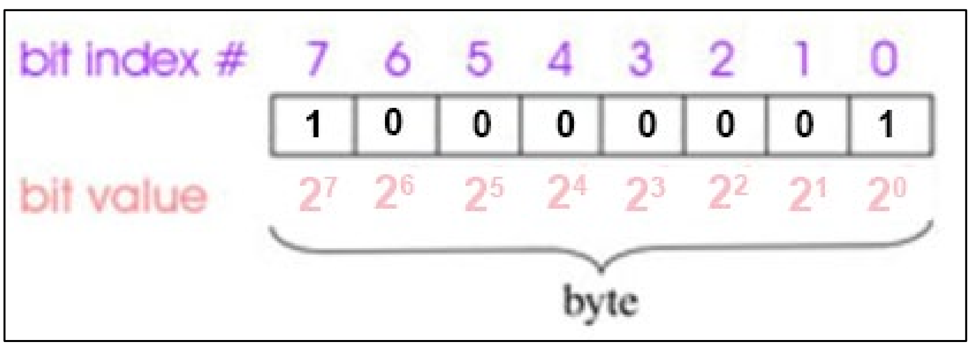

Figure 1. This figure shows the bit flag format. The bit index positions are numbered from right (bit index 0) to left (bit index 7), and each index stores the result of a screen test. The bit values from right to left solve respectively to 1, 2, 4, 8, 16, 32, 64, and 128. In this example, bit index 0 and bit index 7 are set to true (1) with corresponding bit values 20 and 27 equaling '1' and '128'; which when summed equal '129'.

1.2 File Information

1.2.1 Format

Data are provided in HDF-EOS5 32-bit signed integer format and include additional variables and attributes that conform to the netCDF CF-1.6 convention for local attributes, global attributes and georeferencing. For software and more information, visit the HDF-EOS website.

1.2.2 Contents

As shown in Figure 2, each data file includes three data fields (CGF_NDSI_Snow_Cover, Cloud_Persistence, and VNP10A1_NDSI_Snow_Cover), two quality fields (Basic_QA and Algorithm_bit_flags_QA), three ancillary data fields (Projection, XDIM, and YDIM), and one metadata field (StructMetadata).

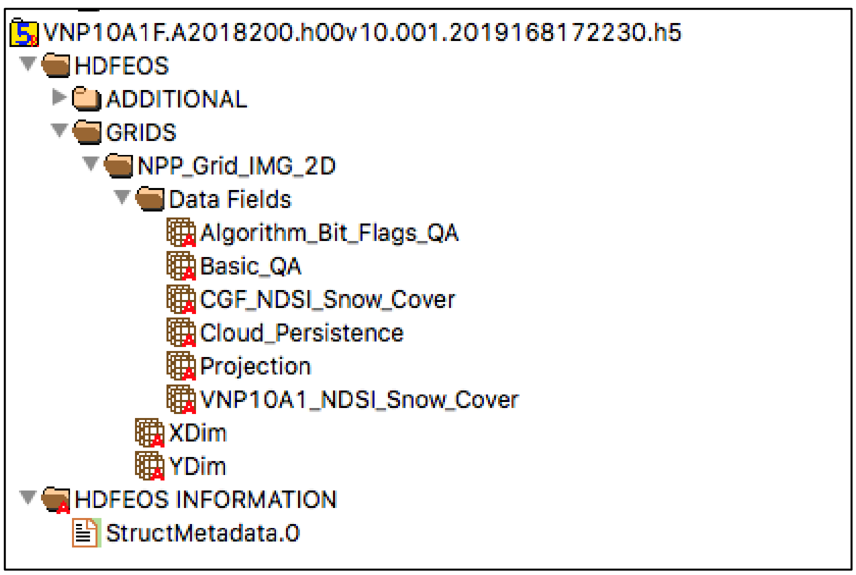

Figure 2. This figure shows the fields included in each VNP10A1F data file as displayed with HDFView software.

1.2.3 Directory Structure

A data directory exists for each day of data and includes data files, browse image files, and metadata files for each granule. A granule exists for each tile in the MODIS Sinusoidal Tile Grid. See the Grid Description section below for tile grid details.

1.2.4 Naming Convention

Files are named according to the following convention and as described in Table 2.

File Name Convention

`VNP[PID].A[YYYY][DDD].h[NN]v[NN].[VVV].[yyyy][ddd][hhmmss].h5`

Table 2. File Name Variables

Variable	Description
VNP	VIIRS Suomi NPP
PID	10A1F
A	Acquisition date follows
YYYY	Acquisition year
DDD	Acquisition day of year
h[NN]v[NN]	Horizontal tile number and vertical tile number (See Grid Description below)
VVV	Version (Collection) number
yyyy	Production year
ddd	Production day of year
hhmmss	Production hour/minute/second in GMT
.h5	HDF-EOS5 formatted data file

File Name example

`VNP10A1F.A2018200.h35v10.001.2019126222553.h5`

1.3 Spatial Information

1.3.1 Coverage

The spatial coverage is global. The following sites offer tools that track and predict NPP's orbital path:

- Space Science and Engineering Center (SSEC) NPP Orbit Tracks
- NASA LaRC Satellite Overpass Predictor (includes viewing zenith, solar zenith, and ground track distance to specified lat/lon)

1.3.2 Projection

This data set is georeferenced to an equal-area sinusoidal projection. Areas on the grid are proportional to the same areas on Earth and distances are correct along all parallels and the central meridian. Shapes become increasingly distorted away from the central meridian and near the poles. The data are neither conformal, perspective, nor equidistant. Meridians, except for the central meridian, are represented by sinusoidal curves and parallels are represented by straight lines. The central meridian and parallels are lines of true scale.

1.3.3 Grid Description

As shown in Figure 3, data are gridded using the MODIS Sinusoidal Tile Grid, which comprises 460 non-fill tiles that each cover 10° by 10° at the equator or approximately 1200 km by 1200 km. Each data granule covers one tile and consists of 3,000 rows and 3,000 columns.

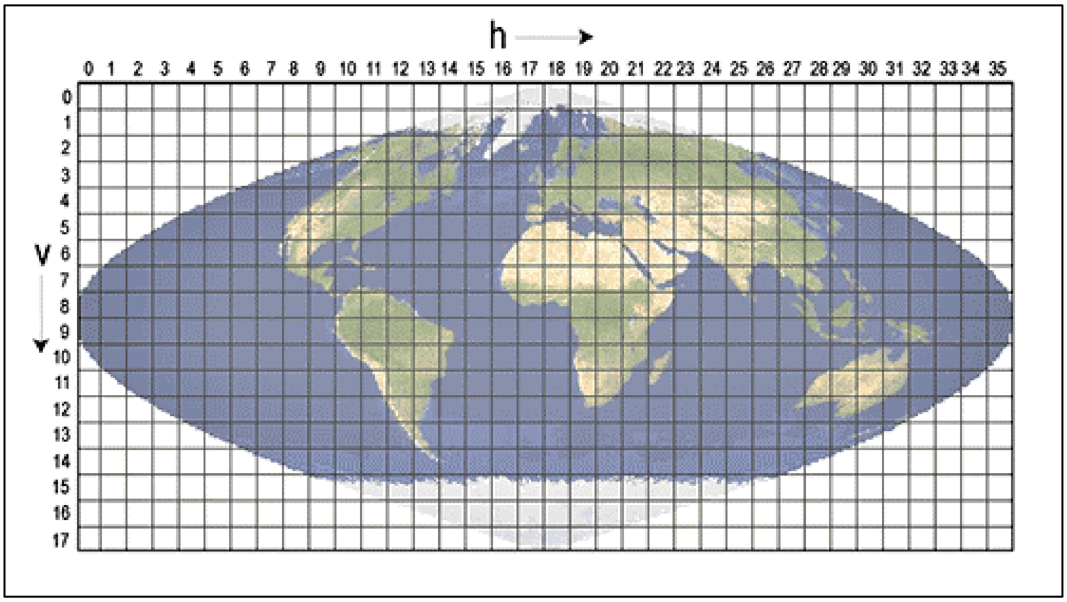

Figure 3. MODIS Sinusoidal Tile Grid

1.3.4 Spatial Resolution

The nominal spatial resolution is 375 meters.

1.3.5 Geolocation

The following tables provide information for geolocating this data set.

Table 3. Projection Details

Region	Global
Geographic coordinate system	WGS84
Projected coordinate system	Sinusoidal Grid
Longitude of true origin	0°
Latitude of true origin	0°
Scale factor at longitude of true origin	1.0
Datum	WGS 84
Ellipsoid/spheroid	6371007.181000 meters
Units	Meter
False easting	0°

False northing	0°
SR-ORG code	6974
PROJ4 string	+proj=sinu +lon_0=0 +x_0=0 +y_0=0 +ellps=WGS84 +datum=WGS84 +units=m +no_defs
Reference	https://spatialreference.org/ref/sr-org/6974/html/

Table 4. Grid Details

Region	Global
Grid cell size (x, y pixel dimensions)	375 m
Number of rows	3000
Number of columns	3000
Nominal gridded resolution	375 m
Grid rotation	N/A
Upper left corner point (m)	-20015109.354(x), 10007554.677(y)
Lower right corner point (m)	20015109.354(x), -10007554.677(y)

1.4 Temporal Information

1.4.1 Coverage

The temporal coverage of this data set extends from 19 Jan 2012 to the present. However, because the NDSI depends on visible light, data are not produced for the night phase of each orbital period or for those portions of fall and winter in polar regions when viewing conditions are too dark. If you cannot locate data for a particular date or time, check the VIIRS Data Outages Web page.

1.4.2 Resolution

Daily

1.5 Sample Data Image

The sample images below show NDSI_Snow_Cover (Figure 4) and CGF_NDSI_Snow_Cover (Figure 5) for the same date and tile, detected over the Rocky Mountains and High plains in January 2018. A comparison of the two images shows the effect of the CGF algorithm in producing a 'cloud free' image.

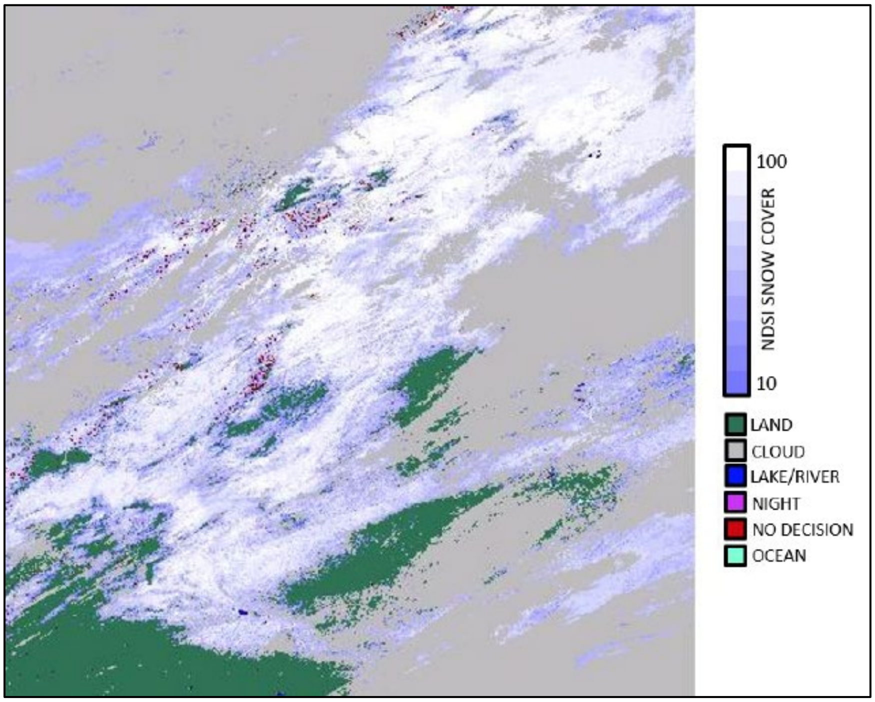

Figure 4. This figure shows snow cover over the Rocky Mountains and High Plains from tile h10v04, detected 7 January 2018.

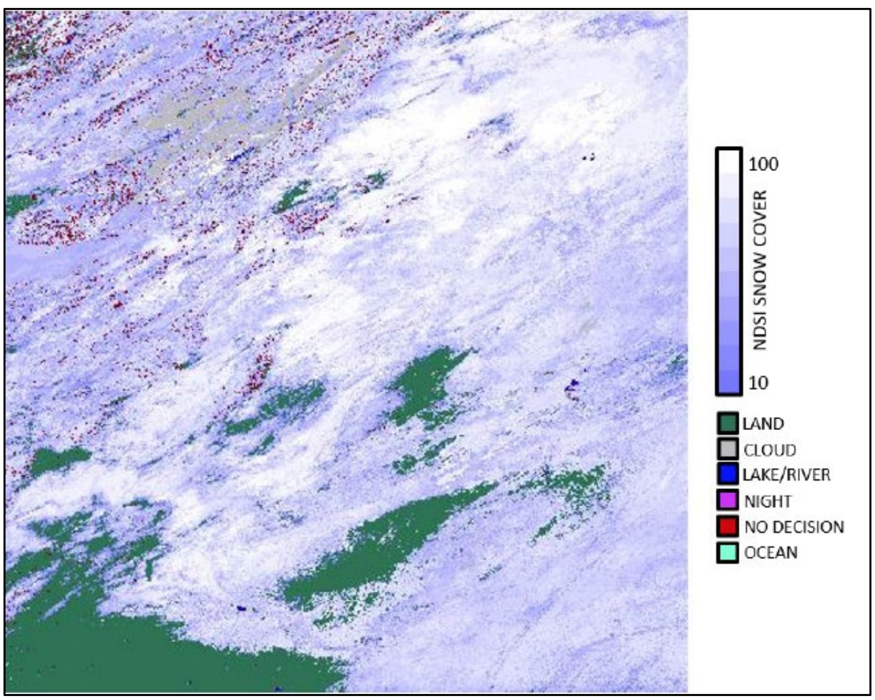

Figure 5. This figure shows CGF_NDSI_Snow_Cover from tile h10v04, detected 7 January 2018. This graphic shows a nearly 'cloud free' image of snow cover, which was attained on the seventh consecutive day of CGF algorithm processing.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The purpose of the CGF snow cover product (VNP10A1F) is to provide a daily cloud-free map of snow cover extent. The CGF snow cover parameter provides an estimate of the snow cover that might exist under current cloud cover. This field is generated from VNP10A1 Version 1 snow cover by replacing cloud-covered observations from the current day with non-cloud (clear view) observations from the previous day. On the first day of VNP10A1F production, the CGF snow cover values will be the same as the VNP10A1 snow cover values. Over time, the cloud cover in the CGF field will decline, eventually to zero, as non-cloud observations replace cloud observations.

The CGF snow cover product is produced as a 12-month sequence corresponding to the United States Geological Service (USGS) 'water year', which begins on 1 October and ends on 30 September. The 'water year' period is maintained for each year, except for the first year, which began on 19 January 2012. On the first day of the 'water year' (or first day of temporal coverage) VNP10A1F snow cover is produced as a copy of the VNP10A1 snow cover and cloud persistence values are set to '1' for grid cells that include cloud cover.

A user can determine if the VNP10A1F is the first day of a time series or a day in the series by reading the global attribute 'FirstDayOfSeries.' 'FirstDayOfSeries' is set to 'Y' for the first day in a time series and to 'N' for all other days in the time series. The global attribute 'TimeSeriesDay' is the count of days in the series since the first day.

2.2 Acquisition

VIIRS scans the entire globe every one to two days. As such, most locations on Earth are imaged at least once per day and more frequently where swaths overlap, such as near the poles. Suomi NPP's sun-synchronous, near-circular polar orbit is timed to cross the equator from south to north (ascending mode) at approximately 1:30 P.M. local time. The repeat cycle is 16 days (quasi 8-day).

2.3 Processing

The data source for the VNP10A1F product is the VNP10A1 Version 1 product. The VIIRS CGF algorithm inputs the current day VNP10A1 snow cover and the previous day VNP10A1F snow cover. The current day CGF snow cover field is generated by replacing VNP10A1 cloud-covered observations from the current day with VNP10A1F non-cloud (clear view) observations from the previous day. The persistence of cloud cover is tracked by incrementing the count of days with cloud cover observed for each grid cell. The count of days observed since the last non-cloud observation is tracked in the 'Cloud_Persistence' parameter. When a cloud-free observation occurs, the count of days with cloud persistence is reset to 0; indicating a cloud-free observation occurred on the current day. A cloud persistence value of '1' indicates that the current day was cloudy. A cloud persistence value greater than '1' is the count of consecutive days of cloud cover previously observed for a cell.

If there is fill data in orbit gaps or missing parts in VNP10 Version 1 swaths, the fill data is replaced with a non-fill data value from the previous day CGF snow cover map and the cloud persistence count is incremented by one. There are some missing days of VNP10A1 tiles in the data record. When a missing tile is encountered, the previous day VNP10A1F becomes the current day CGF snow cover and the cloud persistence data are incremented by one for all the cells. The global attribute 'MissingDaysOfVNP10A1' reports the number of missing day(s).

2.4 Quality

CGF snow cover can be evaluated relative to VNP10A1 Version 1 snow cover by comparing the CGF snow cover to the current day of VNP10A1 snow cover. To facilitate this comparison, the current day 'VNP10A1_NDSI_Snow_Cover' is provided with this data set (VNP10A1F).

The 'Basic_QA' field provides general snow cover quality assessment and the 'Algorithm_Bit_Flag_QA' field provides algorithm specific data screen results. These fields are copied from VNP10A1 Version 1 for non-cloud observations and from previous day VNP10A1F for cloud-covered observations. Both the snow Basic_QA and Algorithm_Bit_Flag_QA were set during VNP10 Version 1 processing. For a detailed description of the accuracy, uncertainty, and errors associated with VNP10 Snow Cover, see Section 3.4 in the VIIRS Snow Products User Guide (Riggs et al. 2019).

2.5 Instrument Description

The VIIRS instrument is a whiskbroom scanning radiometer with 22 bands (see VIIRS Bands and Bandwidths) covering the spectrum between 0.412 μm and 12.01 μm. Sixteen moderate resolution bands (M-bands), five imaging resolution bands (I-bands), and one panchromatic day-night band (DNB) acquire spatial resolutions at nadir of 750 m, 375 m, and 750 m, respectively. M-bands include 11 Reflective Solar Bands (RSB) and 5 Thermal Emissive Bands (TEBs). I-bands include 3 RSBs and 2 TEBs. For more details about the VIIRS instrument see the Visible Infrared Imaging Radiometer Suite (VIIRS) Sensor Data Record (SDR) User's Guide (Changyong et al. 2013) and the Joint Polar Satellite System (JPSS) VIIRS Radiometric Calibration Algorithm Theoretical Basis Document (ATBD) (Baker, 2013).

The following table lists select technical specifications for the VIIRS instrument:

Table 5. VIIRS Specifications

Variable	Description
Orbit	829 km (nominal) altitude, 1:30 P.M. ascending node, sun-synchronous, near-polar, circular
Scan Rate	1.779 sec/rev, 202.3 deg/sec
Scan Width	±56.28° (Earth view)
Imaging Optics	19.1 cm aperture, 114 cm focal length
Swath Dimensions	3060 km cross-track, 12 km along track at nadir
Samples per Band	M-bands: 6304 samples at 0.312 mrad/sample (3200 aggregated pixels) I-bands: 12608 samples at 0.156 mrad/sample (6400 aggregated pixels) DNB: 4064 pixels at 0.149 to 0.894 mrad/pixel
Weight	275 kg
Power	200 W (single orbit average)
Data Rate	10.5 Mbps (max)
Quantization	12 bit –14 bit A/D converters for lower noise
Launch date	28 October, 2011
Design Life	7 years (5 year mission)

3 SOFTWARE AND TOOLS

For general tools that work with HDF-EOS data, see the NSIDC HDF-EOS web page.

4 CONTACTS AND ACKNOWLEDGMENTS

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5 REFERENCES

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6 DOCUMENT INFORMATION

6.1 Publication Date

August 2019

6.2 Date Last Updated

22 December 2021