VIIRS/[NPP|JPSS1|JPSS2] Snow Cover Daily L3 Global 375m CMG, Version 2

USER GUIDE

How to Cite These Data

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

VNP10D1F:

Riggs, G. A. and D. K. Hall. 2025. *VIIRS/NPP* Snow Cover Daily L3 Global 375m CMG*, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/F3VW9TYIK26A. [Date Accessed].

VJ110D1F:

Riggs, G. A. and D. K. Hall. 2025. *VIIRS/JPSS1* Snow Cover Daily L3 Global 375m CMG*, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/FPB0B5CD1RVA. [Date Accessed].

VJ210D1F:

Riggs, G. A. and D. K. Hall. 2025. *VIIRS/JPSS2 Snow Cover Daily L3 Global 375m CMG, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/5F2SPLA31UGD. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/VNP10D1F, https://nsidc.org/data/VJ110D1F, AND https://nsidc.org/data/VJ210D1F

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DATA DESCRIPTION

These VIIRS Level 3 data sets provide daily estimates of cloud-gap-filled (CGF) snow cover on a global Climate Modeling Grid (CMG) at 375m spatial resolution. They are produced by reprojecting V[NP|J1|J2|10A1F product tiles to the CMG geographic projection. V[NP|J1|J2]10D1F data also includes the NDSI_Snow_Cover and Cloud_Persistence data layers from V[NP|J1|J2]10A1F.

Snow-covered land typically has very high reflectance in visible bands and very low reflectance in the shortwave infrared bands. The Normalized Difference Snow Index (NDSI) reveals the magnitude of this difference, with values greater than 0 typically indicating the presence of at least some snow. The VIIRS snow cover algorithm computes NDSI using VIIRS image bands I1 (0.64 µm, visible red) and I3 (1.61 µm, shortwave near-infrared) and then applies a series of data screens designed to alleviate likely errors and flag uncertain snow detections. Grid cells in the input V[NP|J1|J2]10A1F data which are obscured by cloud cover are filled by retaining clear-sky views of the surface from previous days (Hall et al., 2010). The Cloud_Persistence parameter tracks the number of days in each cell since the last clear-sky observation.

VIIRS travels on board the Suomi-NPP and the JPSS-1 and JPSS-2 satellites (the latter two were renamed NOAA-20 and NOAA-21 after they became operational). While VIIRS data from these satellites are stored in separate product series – VNP, VJ1 and VJ2, respectively – the algorithms that produce snow cover data in VIIRS Collection 2.0 are consistent between the three satellite missions and also with MODIS Collection 6.1. This is intended to simplify the process of merging snow cover data from the S-NPP, JPSS-1, JPSS-2, Terra, and Aqua products (Hall et al., 2019; Thapa et al., 2019; Riggs and Hall, 2020; Zhang et al., 2020; and Román et al., 2024.

1.1 Parameters

Scientific Data Sets (SDSs) included in VNP10D1F, VJ110D1F, and VJ210D1F are listed in Table 1.

Table 1. SDS Details

Parameter	Description and Values
`CGF_NDSI_Snow_Cover`	Gridded cloud-gap-filled NDSI snow cover values and data flag values, stored as 8-bit unsigned integers. 0–100: NDSI snow cover valid range 201: no decision; 211: night 237: lake; 239: ocean 250: cloud; 251: missing L1B data 252: L1B data failed calibration; 253: onboard VIIRS bowtie trim 254: L1B fill

Parameter	Description and Values
`Cloud_Persistence`	Count of consecutive days with cloud cover. 0-200: valid data range 201: no decision; 211: night 237: lake; 239: ocean 243: Antarctica; 250: cloud 251: missing L1B data; 252: L1B data failed calibration 253: onboard VIIRS bowtie trim; 254: L1B fill
`lat`	Latitude in degrees north -90.0–90.0: valid data range
`long`	Longitude in degrees east -180.0–180.0: valid data range

1.2 File Information

1.2.1 Format

These L3 products are provided in HDF-EOS5 format and use NetCDF Climate and Forecast (CF-1.6) conventions for global and local attributes and to geolocate the variables. For software and more information, visit the HDF-EOS website.

1.2.2 File Contents

As shown in Figure 1, each data file includes four data fields (CGF_NDSI_Snow_Cover, Cloud_Persistance, lat, and long).

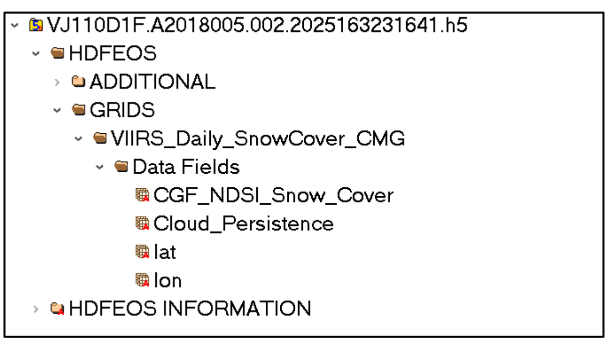

Figure 1. Parameters included in each V[NP|J1|J2]10D1F file, as displayed with HDFView software. All data fields are two-dimensional.

The metadata within HDF-EOS5 data files contain global attributes, which store important details about the data, and local attributes such as keys to data fields. Each data file also has a corresponding XML (.xml) metadata file. For detailed information about metadata fields and values, consult the SNPP/JPSS1 VIIRS Snow Cover Products Collection 2 User Guide.

1.2.3 Naming Convention

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

`V[SAT]10D1F.A[YYYY][DDD].h[NN]v[NN].[VVV].[yyyy][ddd][hhmmss].h5`

Table 2. File Name Variables

Variable	Description
SAT	Satellite designator: NP (Suomi-NPP) , J1 (JPSS-1), or J2 (JPSS-2)
10D1	Product ID
A	Acquisition date follows
YYYY	Acquisition year
DDD	Acquisition day of year
VVV	Version (Collection) number
yyyy	Production year
ddd	Production day of year
hhmmss	Production hour/minute/second in Greenwich Mean Time (GMT)
.h5	HDF-EOS5 formatted data file

File name examples:

VNP10D1F.A2023048.002.2025190135121.h5

VJ110D1F.A2018005.002.2025163231641.h5

VJ210D1F.A2025224.002.2025231181959.h5

1.3 Spatial Information

1.3.1 Coverage

Global

1.3.2 Projection

MODIS CMG data sets are provided in geographic latitude/longitude coordinates. For additional details about the MODIS CMG see the NASA MODIS Lands | MODIS Grids web page.

1.3.3 Resolution

The nominal spatial resolution is 375 meters.

1.3.4 Geolocation

This data set conforms to the WGS 84 coordinate reference system (EPSG 4326).

Table 3. Grid Details

Grid cell size (x, y dimensions)	375 m
Number of rows	108000
Number of columns	54000
Nominal gridded resolution	375 m
Grid rotation	N/A
Geolocated upper left point in grid	-180.0°(x), 90.0°(y)
Geolocated lower right point in grid	180.0°(x), -90.0°(y)

1.4 Temporal Information

1.4.1 Coverage

VNP10D1F data are available from 19 January 2012 to present.
VJ110D1F data are available from 5 January 2018 to present.
VJ210D1F data are available from 10 February 2023 to present.

If you cannot locate data for a particular date or time, check the MODIS & VIIRS Data Outages Web page.

1.4.2 Resolution

Daily

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The snow detection algorithm in VIIRS Collection 2.0 is consistent with MODIS Collection 6.1. For a detailed description of the MODIS snow detection algorithm, see Hall et al. (2001). For a revised explanation of the NDSI snow cover algorithm theory, see the Riggs et al. (2015). The MODIS and VIIRS snow cover algorithms both use the NDSI snow detection algorithm, albeit adjusted for sensor and input data differences.

The purpose of these CGF snow cover products is to provide daily cloud-free maps of snow cover. The CGF_NDSI_snow_cover parameter provides an estimate of the snow cover that might exist under current cloud cover.

2.2 Instrumentation

The Visible Infrared Imaging Radiometer Suite (VIIRS) instrument collects visible and infrared imagery in 22 spectral bands ranging from 0.412 to 12.01 micrometers. 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 (see the VIIRS Bands and Bandwidth Technical Reference for details on wavelength and resolution of individual bands). More details about the VIIRS instrument are available in the VIIRS Sensor Data Record User Guide and the JPSS VIIRS Radiometric Calibration Algorithm Theoretical Basis Document.

VIIRS orbits the globe about 14 times a day and as such, most locations on Earth are imaged at least once per day and more frequently where swaths overlap (at higher latitudes). All three satellites complete a sun-synchronous, near-circular polar orbit in sequence, each crossing the equator within a 75-minute span. JPSS-2 crosses the equator from south to north at approximately 1:10 p.m. local time (and from north to south at 1:10 a.m.), followed by S-NPP at approximately 1:30 p.m. local time, and finally JPSS-1 at approximately 2:20 p.m. local time.

Table 5 lists technical specifications for the VIIRS instrument, and the following sites offer tools that track and predict each satellite's orbital path:

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

Table 4. VIIRS Technical Specifications

Variable	Description
Orbit	829 km (nominal) altitude, 1:30 p.m. mean local solar time, sun-synchronous, polar, near-circular (Suomi-NPP orbit; JPSS-2 and JPSS-1 fly on the same orbit, with the former preceding by 20 minutes and the latter lagging by 50 minutes)
Scan Rate	1.779 sec/rev or 202.3 deg/sec
Swath Dimensions	3060 km (cross track) by ~12 km (along track at nadir) – nearly global coverage every day
Size	1.34 m x 1.41 m x 0.85 m
Weight	275 kg
Power	319 W (single orbit average)
Data Rate	7.674 Mbps (average), 10.5 Mbps (max)
Quantization	12 bits
Spatial Resolution (at nadir)	375 m (Imagery resolution bands) 750 m (Moderate resolution bands)
Design Life	7 years

2.3 Inputs

These V[NP|J1|J2]10D1F Level-3 data sets are generated from VIIRS/[NPP|JPSS1|JPSS2] Snow Cover Daily L3 Global 375m SIN Grid, Version 2 data sets (available as VNP10A1F, VJ110A1F, and VJ210A1F).

2.4 Processing

The V[NP|J1|J2]10D1F algorithm is used to re-project the NDSI_Snow_Cover and Cloud_Persistence data layers from V[NP|J1|J2]10A1F, remapping the input sinusoidal projected tiles into a global geographic projection using static latitude and longitude files. The number of input files per day ranges between 320 to 340 tiles, depending on the season, and both input and output data have a spatial resolution of 375 m.

2.4.1 NDSI_Snow_Cover

V[NP|J1|J2]10D1 snow cover data represents the optimal snow cover extent observation for each day of the input V[NP|J1|J2]10A1F. NDSI snow cover values range between 0 (no snow cover) to 100 (total snow cover). Users can convert the NDSI snow cover values to percent snow coverage using the equations outlined in Stillinger et al. (2023). Flag values representing night (211), lakes (237), ocean

(239), and clouds (250) are included. Additional flag values representing missing or errant input data are also available.

The algorithm also applies a land water mask (LWM) to certain subsets of the snow cover data set, which is used to replace missing data with a more useful flag value. This value swap is utilized for observation periods adjacent to the solstice, when polar darkness obscures visibility and the VIIRS instrument is in night mode. The LWM identifies regions of land and ocean. Missing data over land during polar night is replaced with the “night” flag, while missing data over land during daylight retains the “missing” flag. By replacing the missing data from the polar regions with night values for these time periods, land extent is maintained. Missing data over oceans is replaced with the “ocean” flag for both polar night and daylight. The implementation of this mask ensures compatibility with the V[NP|J1|J2]10C1 and MOD10C1 products, which also employ an LWM. Additional details about the LWM can be found in the SNPP/JPSS1 VIIRS Snow Cover Products Collection 2 User Guide (Riggs and Hall, 2025).

2.4.2 Cloud_Persistence

V[NP|J1|J2]10D1 cloud persistence data represents the number of consecutive days of cloud cover, as observed in the input V[NP|J1|J2]10A1F data. Grid cells which have a value of 0 indicate the presence of no cloud cover for that day’s observation. Each grid cell which has a value greater than 1 indicates the number of previous consecutive days during which clouds obscured the view of that geographic location, hindering snow cover observations. Higher numbers of consecutive cloudy days indicate more outdated snow cover observations for that particular grid cells.

> Because of the great difficulty in discriminating between clouds and snow over Antarctica in the Level-2 snow detection and cloud mask algorithms, Antarctica is intentionally mapped as 100% snow cover in the `Snow_Cover` parameter of these Level-3 products. It is also flagged as “Antarctica” in all the data fields (flag value = 243). These data sets should not be used for the purpose of observing actual snow cover in Antarctica.

2.5 Errors

Given these VIIRS data products are direct derivatives of the V[NP|J1|J2]10A1 data sets, users should be aware of the main sources of error affecting the upstream products.

2.5.1 Snow Cover

The NDSI technique for snow detection has been shown to be a robust indicator of snow around the globe. Numerous studies using the MODIS snow products have reported accuracy statistics under cloud-free conditions in the range of 88-93% (see list of publications on the NASA MODIS website). The VIIRS snow cover algorithm has proven consistent with the MODIS snow cover algorithm over varying landscapes (Thapa et al., 2019; Zhang et al., 2020). Accuracy assessments using JPSS-1 data are underway and have not yet been published.

Warm surfaces, low reflectance in the visible range (which may falsely lead to low positive NDSI), unusually high SWIR reflectance, cloud/snow confusion, heavily forested surfaces, lake ice, and bright surface features are conditions known to adversely affect snow cover detection and may also interfere with the data screens, leading to uncertainty and errors in snow cover reporting (Rittger et al., 2013; Stillinger et al., 2023). These conditions and their implications are discussed in detail in the SNPP/JPSS1 VIIRS Snow Cover Products Collection 2 User Guide.

2.5.2 Geolocation

Geolocation errors may occur due to a “day-to-day” wobble in the position of individual grid cells. This geolocation wobble is most commonly observed as daily 1-2 grid cells shifts in the position of coastlines in the horizontal or vertical direction. This shift may have subtle impacts on the geolocated boundaries of snow-covered areas.

3 VERSION HISTORY

Table 5. Version History

Version	Date Implemented	Impacted Temporal Coverage	Description of Changes
V2 / C2	January 2026	10 February 2023 to present	Initial release of VJ210D1F
V2 / C2	July 2025	5 January 2018 to present	Initial release of VJ110D1F
V2 / C2	July 2025	19 January 2012 to present	Initial release of VNP10D1F

4 RELATED DATA SETS

VIIRS data @ NSIDC

MODIS data @ NSIDC

5 RELATED WEBSITES

Nasa Goddard Space Flight Center | Suomi-NPP VIIRS Land

MODIS Snow/Ice Global Mapping Project

Earthdata | VIIRS is Here

6 REFERENCES

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7 DOCUMENT INFORMATION

7.1 Publication Date

July 2025

7.2 Date Last Updated

January 2026