# VIIRS/[NPP|JPSS1] Sea Ice Cover Daily L3 Global 375m EASE-Grid 2.0 Day, Version 2

## USER GUIDE

**How to Cite These Data**

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

*VNP29P1D:*

Riggs, G. A., Tschudi, M. A., and D. K. Hall. 2023. *VIIRS/NPP Sea Ice Cover Daily L3 Global 375m EASE-Grid 2.0 Day, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/F6WVWUR3AH3W. [Date Accessed].

*VJ129P1D:*

Riggs, G. A., Tschudi, M. A., and D. K. Hall. 2023. *VIIRS/JPSS1 Sea Ice Cover Daily L3 Global 375m EASE-Grid 2.0 Day, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/7UNUBC8FWIHV. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/VNP291D AND https://nsidc.org/data/VJ1291D

National Snow and Ice Data Center

# TABLE OF CONTENTS

# 1 DATA DESCRIPTION

These VIIRS Level 3 data sets are composites of daily sea ice cover, generated from the respective satellite 6-minute swath data (V[NP|J1]29) and regridded into 10° by 10° tiles at a 375 m resolution grid on the EASE-Grid 2.0 North and South polar projections.

Sea ice is detected using the Normalized Difference Snow Index (NDSI). Snow-covered sea ice typically has very high reflectance in visible bands and very low reflectance in the shortwave infrared bands; the NDSI reveals the magnitude of this difference. The VIIRS sea ice 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.

VIIRS travels on board the Suomi-NPP and JPSS-1 satellites (the latter was renamed NOAA-20 after it became operational). While VIIRS data from these satellites are stored in separate product series – VNP and VJ1, respectively – the algorithms that produce sea ice cover data in VIIRS Collection 2.0 are consistent between them.

## 1.1 Parameters

The Scientific Data Sets (SDSs) included in VNP29P1D and VJ129P1D are listed in Table 1.

Table 1. SDS Details

| Parameter | Description and Values |
|---|---|
| `SeaIceCover_mode` | Mode of all V[NP|J1]29 observations mapped into a grid cell. Includes data flags values.<br>0 – 1: valid range, where 0 = 0% ice and 1 = 100% ice<br>200: missing; 201: no decision<br>211: night; 225: land<br>237: inland water; 250: cloud<br>252: L1B data failed calibration; 253: onboard VIIRS bowtie trim<br>254: L1B fill; 255: L3 fill |
| `SeaIceCover_nobs` | Count of valid sea ice cover observations, from all the V[NP|J1]29 observations mapped into a grid cell.<br>0-127: valid range<br>255: fill value |
| `n_obs` | Count of all the V[NP|J1]29 observations mapped into a grid cell. |
| `Projection` | Attributes for the Lambert azimuthal equal-area projection. |

## 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 2, each data file includes three data fields (`SeaIceCover_mode`, `SeaIceCover_nobs`, and `n_obs`) and an ancillary field with the projection attributes. X and Y coordinate arrays are included for the specified projection (`XDim` and `YDim`).

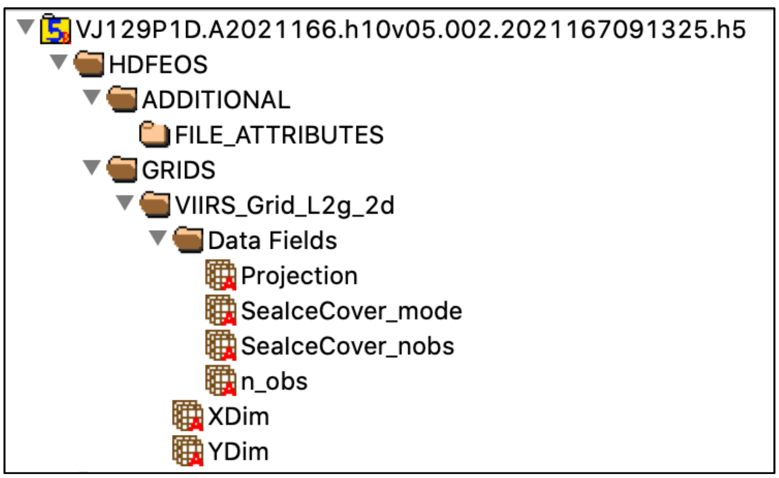


Figure 1. Parameters included in each V[NP|J1]29P1D file, as displayed with HDFView software. All data fields are two-dimensional except for `Projection`, which is an empty, attribute-only field.

> 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 Sea Ice 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.

**File naming convention:**

`V[SAT]29P1D.A[YYYY][DDD].h[NN]v[NN].[VVV].[yyyy][ddd][hhmmss].h5`

Table 2. File Name Variables

| | |
|---|---|
| SAT | Satellite designator: NP (Suomi-NPP) or J1 (JPSS-1) |
| 29P1D | Product ID |
| A | Acquisition date follows |
| YYYY | Acquisition year |
| DDD | Acquisition day of year |
| h[NN]v[NN] | Horizontal tile number and vertical tile number (see Section 1.3.2 for details) |
| 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:**

`VNP29P1D.A2019208.h10v07.002.2021076002920.h5`

`VJ129P1D.A2021166.h10v05.002.2021167091325.h5`

# 1.3 Spatial Information

## 1.3.1 Coverage

Poleward of 40°N and 50°S

## 1.3.2 Projection and Tile Grid

Data files are provided as 10° by 10° tiles of data gridded in the EASE-Grid 2.0 polar azimuthal equal-area projections for the Northern and Southern hemispheres. The tile coordinate system is composed of horizontal and vertical ordered pairs. The northern grid extends from tile h00,v00 in the upper left corner to tile h18,v18 in the lower right corner. The southern grid extends from tile h00,v20 in the upper left corner to tile v18,h38 in the lower right corner. See the EASE-Grid Tile Locations and Bounding Coordinates for MODIS and VIIRS Sea Ice Products technical reference for additional grid information.

Each individual tile contains a grid of 2,720 rows by 2,720 columns.

## 1.3.3 Resolution

375 meters

### 1.3.4 Geolocation

The following tables provide information for geolocating tiles in these data sets.

Table 3. Projection Details

| Region | Northern Hemisphere | Southern Hemisphere |
|---|---|---|
| **Geographic coordinate system** | WGS 84 | WGS 84 |
| **Projected coordinate system** | EASE-Grid 2.0 North Lambert Azimuthal | EASE-Grid 2.0 South Lambert Azimuthal |
| **Longitude of true origin** | 0° | 0° |
| **Latitude of true origin** | 90° | -90° |
| **Scale factor at longitude of true origin** | N/A | N/A |
| **Datum** | WGS 84 | WGS 84 |
| **Ellipsoid/spheroid** | WGS 84 | WGS 84 |
| **Units** | Meter | Meter |
| **False easting** | 0° | 0° |
| **False northing** | 0° | 0° |
| **EPSG code** | 6931 | 6932 |
| **PROJ4 string** | +proj=laea +lat_0=90 +lon_0=0 +x_0=0 +y_0=0 +ellps=WGS84 +towgs84=0,0,0,0,0,0,0 +units=m +no_defs | +proj=laea +lat_0=-90 +lon_0=0 +x_0=0 +y_0=0 +ellps=WGS84 +towgs84=0,0,0,0,0,0,0 +units=m +no_defs |
| **Reference** | http://epsg.io/6931 | http://epsg.io/6932 |

Table 4. Grid Details

| | |
|---|---|
| **Grid cell size (x, y pixel dimensions)** | 375 m |
| **Number of rows** | 2,720 |
| **Number of columns** | 2,720 |
| **Nominal gridded resolution** | 375 m |
| **Grid rotation** | N/A |
| **Geolocated upper left point (m)** | `XDim(0)`, `YDim(0)` |
| **Geolocated lower right point (m)** | `XDim(2719)`, `YDim(2719)` |

## 1.4 Temporal Information

### 1.4.1 Coverage

VNP29P1D data are available from 19 January 2012 to present.
VJ129P1D data are available from 5 January 2018 to present.

Because computation of 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 MODIS & VIIRS Data Outages Web page.

### 1.4.2 Resolution

Daily

# 2 DATA ACQUISITION AND PROCESSING

## 2.1 Background

The sea ice detection algorithm in VIIRS Collection 2.0 utilizes the Normalized Difference Snow Index (NDSI) to classify the ocean surface poleward of 40ºN and 50ºS as ice-covered or ice-free. Unlike the snow cover products, no fractional ice cover is detected within a pixel. For a brief description of the sea ice cover detection algorithm see the *Data Acquisition and Processing* section of the V[NP|J1]29 User Guide and Section 3.3 of the SNPP/JPSS1 VIIRS Sea Ice Cover Products Collection 2 User Guide (Riggs et al, 2023). For a detailed description of the VIIRS sea ice detection algorithm, see Tschudi et al. (2017).

## 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). Suomi-NPP's sun-synchronous, near-circular polar orbit is timed to cross the equator from south to north at approximately 1:30 p.m. local time (and from north to south at 1:30 a.m.). JPSS-1 follows the same orbit, lagging S-NPP by 50 minutes. 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 5. 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-1 flies on the same orbit, 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)<br>750 m (Moderate resolution bands) |
| Design Life | 7 years |

## 2.3 Inputs

The V[NP|J1]29P1D Level-3 data sets are generated from the VIIRS/[NPP|JPSS1] Sea Ice Cover 6-Min L2 Swath 375m, Version 2 data sets. Intermediate products (V[NP|J1]29PGD) are generated to contain the stack of V[NP|J1]29 observations, but these are not archived at NSIDC.

## 2.4 Processing

The V[NP|J1]29P1D algorithm reads and un-compacts the intermediate V[NP|J1]29PGD products to create a stack of V[NP|J1]29 observations for each grid cell. The mode of the V[NP|J1]29 observations in the stack is calculated and written into the `SeaIceCover_mode` parameter. The total number of observations with valid or flag values is summed and written into the `n_obs` parameter.

The number of sea ice cover observations, 0 or 1, is summed and written into the `SeaIceCover_nobs` parameter. V[NP|J1]29PGD grid cells that are `FillValue` are output as `FillValue`. V[NP|J1]29PGD grid cells that have zero valid observations are output as `FillValue`. If a grid cell has only one observation, then that observation is the mode. If there are only flag values for a grid cell, then the output will be the mode of flag values, e.g., land or cloud.

## 2.5 Quality Information

Factors that affect accuracy and uncertainty of V[NP|J1]29 sea ice detection are propagated through to analysis of the sea ice cover mode, i.e., no screening of the swath observations is done in the V[NP|J1]29P1D algorithm. The `SeaIceCover_nobs` and `n_obs` parameters provide information on how many of the observations for a day were sea ice cover observations. Reasons for those counts to be different are that there were a mix of observations e.g., clouds or night, observed from different orbits of the day.

The V[NP|J1]29P1D algorithm is different from the MODIS daily sea ice cover (M[O|Y]D29P1D) algorithm which selected only the “best” observation on a day (Riggs and Hall, 2015). If using both MODIS and VIIRS sea ice cover products, the differences in satellites, sensors, and algorithms should be considered.

## 2.6 Errors

Discriminating between clouds and sea ice cover is very challenging and accuracy of cloud detection over sea ice is difficult to evaluate. The cloud mask product V[NP|J1]35_L2 is applied in the L2 sea ice cover algorithm producing V[NP|J1]29. Clouds are masked using the V[NP|J1]35_L2 cloud confidence flag. Cloud mask performance was improved though use of a 1 km rolling gridded snow input and a 1 km vegetation index (VI) file, and algorithm improvements for better delineation of snow at higher latitudes in C2 as described in VIIRS Land C2 Changes. Only “certain clear” observations are considered clear; all other values are interpreted as cloud obscured. If there is sea ice/cloud confusion (error) in the L2 observation, that confusion is propagated into the sea ice cover calculation.

Some error in geolocation may be associated with projecting from geographic coordinates (latitude and longitude) to the EASE-Grid Lambert Azimuthal equal-area projection. Geolocation error may be notable along coastlines, which may appear to shift from day to day between cells of the grid.

# 3 VERSION HISTORY

Table 6. Version History Summary

| Version / Collection | Release Date | Description of Changes |
|---|---|---|
| V2 / C2 | June 2023 | Initial release of VNP29P1D and VJ129P1D. |

# 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

Riggs, G.A. and D.K. Hall. 2015. MODIS Sea Ice Products User Guide to Collection 6.1. NASA Goddard Space Flight Center, Greenbelt, MD. (See PDF)

Riggs, G.A., M.A. Tschudi, and D.K. Hall. 2023. SNPP/JPSS1 VIIRS Sea Ice Cover Products Collection 2 User Guide. (See PDF)

Tschudi, M.A., G.A. Riggs, D.K. Hall, and M.O. Román. 2017. Suomi-NPP VIIRS Sea Ice Cover Algorithm Theoretical Basis Document (ATBD). (See PDF)

# 7 DOCUMENT INFORMATION

## 7.1 Publication Date

June 2023

## 7.2 Date Last Updated

June 2023