MODIS/Terra Snow Cover Daily L3 Global 500m SIN Grid, Version 7

USER GUIDE

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

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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. The MODIS snow cover algorithm calculates NDSI for all land and inland water pixels in daylight using Terra MODIS band 4 (visible green) and band 6 (shortwave near-infrared). The Scientific Data Sets (SDSs) included in this product are listed in Table 1.

1.1 Parameters

Table 1. SDS Details

Parameter	Description	Values
NDSI_Snow_Cover	Gridded NDSI snow cover and data flag values.	NDSI snow cover values and data flags values, stored as 8-bit unsigned integers: 0–100: NDSI snow cover 200: missing data 201: no decision 211: night 237: inland water 239: ocean 250: cloud 254: detector saturated 255: fill
NDSI_Snow_Cover_Basic_QA	A general estimate for the quality of the algorithm result.	Quality assessment flag values: 0: best 1: good 2: ok 3: poor (not used) 4: other (not used) 211: night 239: ocean 255: unusable input or no data

Parameter	Description	Values
NDSI_Snow_Cover_Algorithm_Flags_QA	Algorithm-specific bit flags set for data screens and for inland water.	Bit flag values: Bit 0: Inland water screen Bit 1: Low visible screen failed, snow detection reversed to no snow Bit 2: Low NDSI screen failed, snow detection reversed to no snow Bit 3: Combined temperature/height screen failed • brightness temperature ≥ 281 K, pixel height < 1300 m, flag set, snow detection reversed to not snow, OR; • brightness temperature ≥ 281 K, pixel height ≥ 1300 m, flag set, snow detection NOT reversed. Bit 4: High Shortwave IR (SWIR) reflectance screen • Snow pixel with SWIR > 0.45, flag set, snow detection reversed to not snow, OR; • Snow pixel with 0.25 < SWIR ≤ 0.45, flag set to indicate unusual snow condition, snow detection NOT reversed. Bit 5: Cloud possible screen, probably cloudy Bit 6: Cloud possible screen, probably clear Bit 7: Uncertain snow detection due to low illumination
NDSI	Raw NDSI values (i.e. prior to screening).	NDSI Values are scaled by 1 x 10^4. -10000 to 10000: valid values -32768: fill value
orbit_pnt	Pointer to the orbit of the swath mapped into each grid cell. For details, see Section 1.1.2 below.	0-15: valid data range 255: fill value
granule_pnt	Pointer for identifying the swath mapped into each grid cell. For details, see the section 'Using the granule_pnt' below.	0-254: valid data range 255: fill value

Parameter	Description	Values
Projection	Sinusoidal projection attributes.	N/A
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

1.1.1 Interpreting the parameter: NDSI_Snow_Cover_Algorithm_Flags_QA

Pixels determined to have some snow present are subjected to a series of screens that have been specifically developed to alleviate snow commission errors (detecting snow where there is no snow) and to flag uncertain snow detections. In addition, snow-free pixels are screened for very low illumination to prevent possible snow omission errors. Screen results, as well as the location of inland water, are stored as bit flags in the 'NDSI_Snow_Cover_Algorithm_Flags_QA' SDS. Refer to Appendix A of this document for a detailed description of the Algorithm QA Flags.

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. A visual example of the bit flag format for the decimal value '129' is provided in Figure 1.

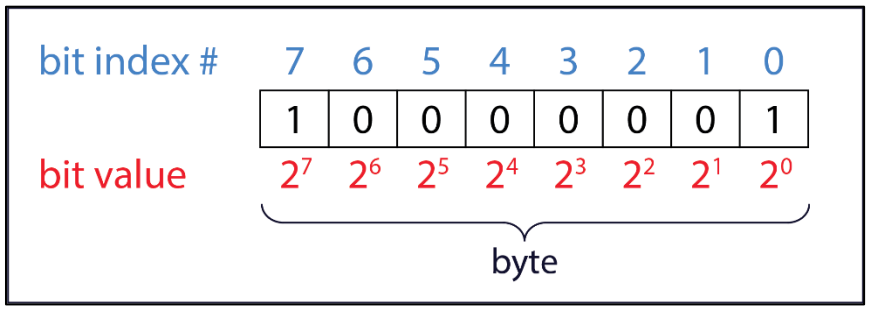


Figure 1. Bit flag format. The bit index positions are numbered from right (bit index 0) to left (bit index 7), and each index stores the result of a screen test. The bit values from right to left solve respectively to 1, 2, 4, 8, 16, 32, 64, and 128. In this example, bit index 0 and bit index 7 are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

1.1.2 Using orbit_pnt

The 'orbit_pnt' SDS includes pointer values for identifying the orbit of the swath mapped into each grid cell. The pointer references by index the list of orbit numbers written to the ORBITNUMBERARRAY metadata object in 'ArchiveMetadata.0'.

1.1.3 Using granule_pnt

The 'granule_pnt' SDS includes pointer values for identifying the swath mapped into each grid cell. The GRANULEPOINTERARRAY metadata object written to 'ArchiveMetadata.0' contains a pointer for each granule that was staged for input to a tile; however, more granules are staged than are actually used. Each granule that is mapped into a tile is assigned a unique positive pointer value, while those that are not are assigned a value of -1. To determine the swath origin of a cell observation, link all the pointers in GRANULEPOINTERARRAY (by index) to the corresponding list of dates and times in GRANULEBEGINNINGDATETIMEARRAY. Then locate the granule in GRANULEPOINTERARRAY with the pointer value contained in 'granule_pnt' and use its index to extract the date and beginning-time string from GRANULEBEGINNINGDATETIMEARRAY.

1.2 File Information

1.2.1 Format

Data are provided in HDF-EOS5 (.h5) format and are stored as 8-bit unsigned integers. For software and more information, visit the HDF-EOS website.

1.2.2 Data File

As shown in Figure 2, each data file includes two data fields (`NDSI_Snow_Cover` and `NDSI`), two data quality fields (`NDSI_Snow_Cover_Basic_QA` and `NDSI_Snow_Cover_Algorithm_Flags_QA`), two geolocation data fields (`Latitude` and `Longitude`), two ancillary data fields (`orbit_pnt` and `granule_pnt`), and three geolocation fields (Projection, `XDim` and `YDim`).

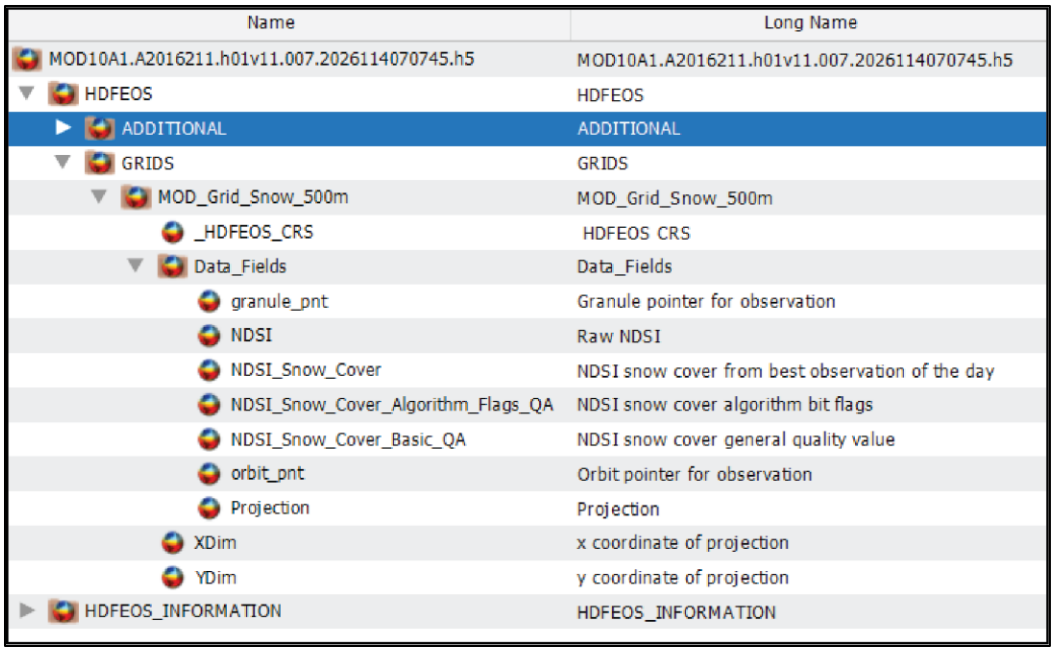


Figure 2. This figure shows the fields included in each data file as displayed with Panoply software.

1.2.3 Ancillary Files

A browse image file (`.jpg`) and metadata file (`.xml`) are provided with each data file.

1.2.4 Naming Convention

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

File naming convention:

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

Table 2. File Name Variables

`MOD`	MODIS/Terra
`PID`	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 Grid section for details)
`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:

`MOD10A1.A2024340.h06v03.007.2026166102304.h5`

Note: Data files contain important metadata including global attributes that are assigned to the file and local attributes like coded integer keys that provide details about the data fields. In addition, each HDF-EOS5 data file has a corresponding XML metadata file (`.xml`) which contains some of the same internal metadata as the HDF-EOS5 file plus additional information regarding user support, archiving, and granule-specific post-production. For detailed information about MODIS metadata fields and values, see the MODIS Snow Products Collection 7 User Guide (Riggs et al., 2025).

1.3 Spatial Information

1.3.1 Coverage

Coverage is global. Terra's sun-synchronous, near-polar circular orbit is timed to cross the equator from north to south (descending node) at approximately 10:30 A.M. local time. See Section 2.2 for additional information regarding Terra's ongoing orbital drift. Complete global coverage occurs every one to two days (more frequently near the poles). The following sites offer tools that track and predict Terra's orbital path:

- Daily Terra Orbit Tracks, Space Science and Engineering Center, University of Wisconsin-Madison
- 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

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 2,400 rows and 2,400 columns at a nominal spatial resolution of 500 m and a true per pixel resolution of 463.31271653 meters in both the X and Y directions. Tiles are labeled with horizontal (h) and vertical (v) indices, starting in the upper left

corner with tile h00v00 and proceeding rightward and downward to tile h35v17 in the bottom right corner.

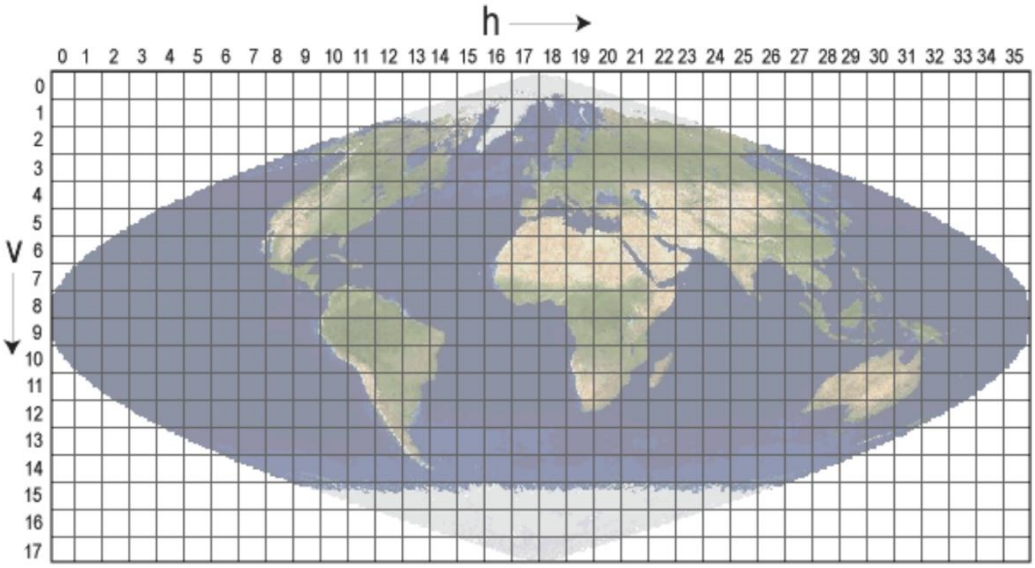


Figure 3. MODIS Sinusoidal Tile Grid

The Software and Tools section below lists resources that can help the user select and work with gridded MODIS data.

1.3.4 Resolution

The nominal spatial resolution is 500 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)	500 m
Number of rows	2400
Number of columns	2400
Nominal gridded resolution	500 m
Grid rotation	N/A
Geolocated upper left point in grid	-20015109.354(x), 10007554.677(y)
Geolocated lower right point in grid	20015109.354(x), -10007554.677(y)

1.4 Temporal Information

1.4.1 Coverage

MODIS Terra data are available from 24 February 2000 to present. However, because the NDSI depends on visible light, data are not produced when viewing conditions are too dark. In addition, anomalies over the course of the Terra mission have resulted in minor data outages. If you cannot locate data for a particular date or time, check the MODIS/Terra Data Outages web page.

1.4.2 Resolution

Daily

1.5 Sample Data Image

Figure 4. This figure shows daily NDSI_Snow_Cover (left) and NDSI_Snow_Cover_Algorithm_Flags_QA (right), acquired on 14 January 2003, from MOD10A1 tile h11v04, covering an area in the western Great Lakes region of North America.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The processing for MODIS Collection 7 (C7) applies required changes to the calibration algorithms to address known satellite issues resulting from the Terra constellation exit and the discontinuation of Terra/Aqua Inclination Adjustment Maneuvers (IAM) and Drag Make-Up (DMU) Maneuver. These issues include:

- Orbital drift
- Optical and electronic crosstalk across different bands and detectors
- Terra mirror side polarization effect

These changes primarily affect the L1 Geolocation and calibrated top of the atmosphere (TOA) land products, which include the L1B input products for MOD10_L2. These changes are described in greater detail in the MODIS Land C7 Changes documentation. No changes have been made to the MODIS snow cover algorithm as part of the C7 updates. These MODIS C7 snow and ice data projects have also been updated from HDF-EOS2 to HDF-EOS5 format. Additionally, this MOD10A1 C7 product does not contain the snow albedo data layer that was available in C6.1.

2.2 Acquisition

MODIS 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 (e.g., near the poles). Terra's sun-synchronous, near-circular polar orbit is timed to cross the equator from north to south (descending node) at approximately 10:30 A.M. local time.

Ongoing changes in the Terra orbit
The Terra flight operations team conducted Terra's last inclination adjust maneuver to maintain Terra's orbit in February 2020. The inclination adjust maneuvers were used to control the platform's 10:30 AM mean local time (MLT) equator crossing. Terra continued to drift and reached a 10:15 AM MLT in October 2022. On 12 October and 19 October 2022, the flight operations team performed two retrograde maneuvers, which caused Terra to exit the Earth Sciences Constellation and lower to an altitude of 694 km by. MLT continued to drift after these maneuvers, reaching 9:06 AM as of December 2025. Estimated monthly changes in the MLT for Terra MODIS can be found here. Orbital drift has impacted MODIS data products, but Terra MODIS is expected to remain operational until the end of the mission in February 2027.

Earlier crossing times for a morning platform like Terra mean lower solar elevations leading to more prevalent shadows. This decrease in orbit altitude alters the spatial coverage of the sensor including possible gaps in spatial sampling, decreased spatial coverage, and higher spatial resolution. Products are mostly expected to be science quality except for reduced grid size (from lower altitude) and without a strict 16-day repeat of observations (from drift and changing orbit).

2.3 Processing

This Level-3 data set is generated from the *MODIS/Terra Snow Cover 5-Min L2 Swath 500m* (MOD10_L2) product.

2.3.1 Snow Cover

A gridding algorithm maps all MOD10_L2 C7 swaths into an intermediate snow cover product (MOD10GA), which is not archived at NSIDC. The algorithms which select the day's best snow cover observation are incorporated into the MOD10GA generation process.

Once the data have been gridded, the selection algorithm identifies the best observation from the one to several MOD10_L2 C7 swaths mapped into each grid cell. The criteria used to select these swaths include: which observations were acquired nearest local solar noon, which were nearest the orbit nadir, and which offer the greatest coverage in the cell. The MOD10GA generation process stores 'NDSI_Snow_Cover', 'NDSI_Snow_Cover_Basic_QA', and 'NDSI' (raw) as separate SDSs, calculates descriptive QA statistics, and then writes the data and metadata into MOD10A1.

For a revised explanation of the NDSI snow cover algorithm theory, see the NASA VIIRS Snow Cover ATBD (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 product differences.

2.4 Quality Information

2.4.1 Basic Quality Assurance

Basic quality assurance (QA) values are stored in 'NDSI_Snow_Cover_Basic_QA' parameter. These values provide a qualitative estimate of the algorithm result for a pixel based on the input data and solar zenith data. The basic QA value is initialized to 'best' and then adjusted as needed based on the quality of the MOD02HKM input radiance data and the solar zenith angle screen. If the MOD02HKM data (TOA reflectance) lie outside the range of 5% to 100%, but are still usable, the QA value is set to 'good'. If the solar zenith angle (SZA) is in range of $70° \leq SZA < 85°$, the QA is set to 'ok', which indicates an increased uncertainty stemming from low illumination. If the input data are unusable, the QA value is set to 'other'. Features that are masked, like 'night' and 'ocean', use the same values as the 'NDSI_Snow_Cover' parameter.

2.4.2 Bit Flags

Bit flags are stored in the 'NDSI_Snow_Cover_Algorithm_Flags_QA' parameter and are used to report data screen results. Bit flags can be used to investigate results for all pixels which have been processed for snow. By examining the bit flags, users can determine if any of the data screens: a) changed a pixel's initial result from 'snow' to 'not snow'; or b) flagged snow cover in a pixel as 'uncertain.' See the MODIS Snow Products Collection 7 User Guide (Riggs et al., 2025) for details regarding how each data screen should be interpreted.

2.5 Errors

2.5.1 Snow Cover

The NDSI technique has proven to be a robust indicator of snow cover. Numerous investigators have utilized MODIS snow cover data sets and reported accuracy in the range of 88% to 93%. Uncertainty associated with detecting NDSI snow cover is presented in the MOD10_L2 User Guide and the MODIS Snow Products Collection 7 User Guide (Riggs et al., 2025).

2.5.2 Swath Selection

Choosing a single, best observation of the day results in a weave or stitch pattern along the edges of adjacent swaths. This pattern is most apparent where cloud cover changed between the

acquisition times of overlapping swaths. In addition, users may encounter interwoven cloud and clear observations in images with snow cover. Differences in viewing geometry can also produce discontinuities in regions where adjacent swaths overlap.

2.5.3 Geolocation

Geolocation error may be visible due to: a) uncertainty in swath geolocation; and b) the process of gridding and projecting the swaths into the MODIS Sinusoidal Tile Grid from day to day. This latter effect, a so-called geolocation wobble, is most commonly observed as daily shifts in the position of a lake, by one or more cells, in the horizontal or vertical directions. Thus, compositing tiles over the course of several consecutive days may result in blurred lake outlines.

2.6 Instrumentation

2.6.1 Description

The MODIS instrument provides 12-bit radiometric sensitivity in 36 spectral bands ranging in wavelength from 0.4 µm to 14.4 µm. Two bands are imaged at a nominal resolution of 250 m at nadir, five bands at 500 m, and the remaining bands at 1000 m. A ±55 degree scanning pattern at an altitude of 705 km achieves a 2330 km swath with global coverage every one to two days.

The scan mirror assembly uses a continuously rotating, double-sided scan mirror to scan ±55 degrees and is driven by a motor encoder built to operate 100 percent of the time throughout the six-year instrument design life. The optical system consists of a two-mirror, off-axis afocal telescope which directs energy to five refractive objective assemblies, one each for the visible, near-infrared, shortwave infrared, middle-wavelength infrared, and long-wavelength infrared spectral regions.

The MODIS instruments on the Terra and Aqua space vehicles were built to NASA specifications by Santa Barbara Remote Sensing, a division of Raytheon Electronics Systems. Table 5 contains the instruments' technical specifications:

Table 5 . MODIS Technical Specifications

Variable	Description
Orbit	~693 km altitude, ~9:30 A.M. descending node (Terra), sun-synchronous, near-polar, circular as of April 2026 (affected by ongoing orbital drift)
Scan Rate	20.3 rpm, cross track
Swath Dimensions	2330 km (cross track) by 10 km (along track at nadir)
Telescope	17.78 cm diameter off-axis, afocal (collimated) with intermediate field stop

Variable	Description
Size	1.0 m x 1.6 m x 1.0 m
Weight	228.7 kg
Power	162.5 W (single orbit average)
Data Rate	10.6 Mbps (peak daytime); 6.1 Mbps (orbital average)
Quantization	12 bits
Spatial Resolution	250 m (bands 1-2) / 500 m (bands 3-7) / 1000 m (bands (8-36)
Design Life	6 years

2.6.2 Calibration

MODIS has a series of on-board calibrators that provide radiometric, spectral, and spatial calibration of the MODIS instrument. The blackbody calibrator is the primary calibration source for thermal bands between 3.5 µm and 14.4 µm, while the Solar Diffuser (SD) provides a diffuse, solar-illuminated calibration source for visible, near-infrared, and shortwave infrared bands. The Solar Diffuser Stability Monitor tracks changes in the reflectance of the SD with reference to the sun so that potential instrument changes are not incorrectly attributed to changes in this calibration source. The Spectroradiometric Calibration Assembly provides additional spectral, radiometric, and spatial calibration.

MODIS uses the moon as an additional calibration technique and for tracking degradation of the SD by referencing the illumination of the moon since the moon's brightness is approximately the same as that of the Earth. Finally, MODIS deep space views provide a photon input signal of zero, which is used as a point of reference for calibration.

3 VERSION HISTORY

The following sites can help you identify the right MODIS data for your study:

- NASA's Earth Observing System Data and Information System | Near Real-Time Data
- NASA Goddard Space Flight Center | MODIS Land Global Browse Images
- MODIS Land Discipline Group (MODLAND) Tile Calculator
- Tile Bounding Coordinates for the MODIS Sinusoidal Grid

The following resources are available to help users work with MODIS data:

- The HDF-EOS to GeoTIFF Conversion Tool (HEG) can reformat, re-project, and perform stitching/mosaicing and subsetting operations on HDF-EOS objects.
- HDFView is a simple, visual interface for opening, inspecting, and editing HDF files. Users can view file hierarchy in a tree structure, modify the contents of a data set, add, delete and modify attributes, and create new files.

- The MODIS Conversion Toolkit (MCTK) plug-in for ENVI can ingest, process, and georeference MODIS data sets, including products distributed with EASE-Grid projections. The toolkit includes support for swath projection and grid reprojection and comes with an API for large batch processing jobs.

4 RELATED WEBSITES

The following resources provide additional information about MODIS Version 7 data:

- The MODIS Snow and Sea Ice Global Mapping Project
- NASA LDOPE | MODIS/VIIRS Land Product Quality Assessment

5 REFERENCES

Hall, D.K., Riggs, G.A., DiGirolamo, N.E., and Roman, M.O. 2019. Evaluation of MODIS and VIIRS cloud-gap-filled snow-cover products for production of an Earth science data record. *Hydrology and Earth System Sciences* 23(12): 5227-5241. https://doi.org/10.5194/hess-23-5227-2019

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Lin, G., Wolfe, R.E., Zhang, P., Tilton, J.C., Dellomo, J.J. and Bin Tan. 2019. Thirty-six combined years of MODIS geolocation trending. *Proc. SPIE 11127*, Earth Observing Systems XXIV, 1112715. http://dx.doi.org/10.1117/12.826598.

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6 DOCUMENT INFORMATION

6.1 Publication Date

November 2026

6.2 Date Last Updated

November 2026

APPENDIX A - DATA SCREENS

This appendix provides a description of the data screen tests applied in the 'NDSI_Snow_Algorithm_bit_flags_QA' SDS.

INLAND WATER SCREEN: BIT 0

Inland water bodies are identified using bit 0. The pixels identified by this flag are set to '237' in the 'NDSI_Snow_Cover' SDS.

LOW VISIBLE REFLECTANCE SCREEN: BIT 1

This screen is used to prevent errors from occurring when the reflectance is too low for the algorithm to perform well. The screen is applied to non-cloud pixels with NDSI ≥ 0.0. If the visible reflectance from MODIS band 2 or band 4 is < 0.07, bit 1 is set and a value of 'no decision' is set for pixels in the 'NDSI_Snow_Cover' SDS.

LOW NDSI SCREEN: BIT 2

This screen is used to prevent errors from occurring where the difference between visible and shortwave reflectance is very small, thus resulting in very low but positive NDSI values. Uncertain snow detections or snow commission errors are common when 0.0 ≤ NDSI < 0.1. Therefore, if NDSI < 0.1 a snow detection is reversed to 'not snow', and bit 2 is set. This flag can be used to find pixels where snow cover detections were reversed to 'not snow'.

ESTIMATED SURFACE TEMPERATURE AND SURFACE HEIGHT SCREEN: BIT 3

This screen serves a dual purpose by linking estimated surface temperature with surface height. It is used to alleviate errors of commission at low elevations that appear spectrally similar to snow but are too warm. It is also used to flag snow detections at high elevations that are warmer than expected. Using the estimated MODIS Band 31 brightness temperature (Tb), if snow is detected in a pixel with height < 1300 m and Tb ≥ 281 K, the pixel is reversed to 'not snow' and bit 3 is set. If snow is detected in a pixel with height ≥ 1300 m and Tb ≥ 281 K, the pixel is flagged as 'unusually warm' and bit 3 is set.

HIGH SWIR REFLECTANCE SCREEN: BIT 4

This screen also serves a dual purpose by: a) preventing non-snow features that appear similar to snow from being detected as snow; b) allowing snow to be detected where snow cover shortwave infrared reflectance (SWIR) is anomalously high. Snow typically has a SWIR reflectance of less than 0.20; however, this value can be higher under certain conditions, like a low sun angle. The SWIR reflectance screen thus utilizes two thresholds. Snow pixels with SWIR reflectance > 0.45 are reversed to 'not snow' and bit 4 is set. Snow pixels with 0.25 < SWIR ≤ 0.45 are flagged as having an 'unusually high SWIR' and bit 4 is set.

CLOUD POSSIBLE SCREENS: BITS 5 & 6

This screen is utilized to identify cloud conditions using the 'Unobstructed FOV Quality Flag' from the MOD35_L2 product. If the MOD35_L2 quality flag is 'confident cloudy' the pixel is masked as 'cloud' and bit 5 is set to 'probably cloudy'. If the MOD35_L2 quality flag is set 'confident clear,' 'probably clear' or 'probably cloud' the condition is interpreted as 'clear' by the algorithm and the bit 6 flag is set to 'probably clear'. These cloud confidence flags are included to enable the snow cover to be evaluated with respect to cloud/snow confusion situations.

SOLAR ZENITH SCREEN: BIT 7

This screen is utilized to identify low illumination conditions. When solar zenith angles exceed 70°, the low illumination challenges snow cover detection. As such, pixels with solar zenith angles > 70° are flagged by setting bit 7. This solar zenith mask is set across the entire swath. **Note**: night is defined as a solar zenith angle ≥ 85°. Night pixels are assigned a value '211' in the 'NDSI_Snow_Cover_Algorithm_Flags_QA' SDS and the 'NDSI_Snow_Cover' SDS.

APPENDIX B - FILE SPECIFICATIONS

```
+=====================================================================+
MODIS/Terra Snow Cover Daily L3 Global 500m SIN Grid
MOD10A1
File Spec Generated: 2026-07-17
PGE Version: 7.0.0
Level:       3
Process ID:  MOD_PR10A1

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Description:

This specification description of the MOD10A1 daily gridded snow
product describes the operational data product.

A general description of the global metadata is given.

Descriptions of the SDS structures are given along with a listing of
the local attributes, dimensions, and content of SDSs.

The daily level 3 snow cover product is archived in HDF-EOS format and
consists of 11 global metadata objects and six SDSs with local
attributes.  The grid scheme used is the Sinusoidal projection.
Spatial resolution of the data product is 500 m. Each data product
file is a tile of the projection and covers a nominal size of 1100 km
by 1100 km (10 degrees by 10 degrees at the Equator).

This daily snow cover product is generated using the L2G Lite snow data
product MOD10GA as input and picks up the first layer from that as primary
```

sds.

GLOBAL ATTRIBUTES

Attribute Name	Data Type	Value
AlgorithmPackageAcceptanceDate	STRING	2024-08-08
AlgorithmPackageMaturityCode	STRING	Normal
AlgorithmPackageName	STRING	MOD_PR10A1
AlgorithmPackageVersion	STRING	7
AssociatedSensorShortName	STRING	MODIS
AutomaticQualityFlag	STRING	Passed
AutomaticQualityFlagExplanation	STRING	No automatic quality assessment done in the PGE
CharacteristicBinAngularSize	float64	[15.]
CharacteristicBinSize	float64	[463.31271653]
Conventions	STRING	CF-1.6, ACDD-1.3
DESCRrevision	STRING	7

DataColumns	int32	[2400]
DataRows	int32	[2400]
DayNightFlag	STRING	Day
EquatorCrossingDate	STRING	2000-04-14
EquatorCrossingDate.2	STRING	2000-04-14
EquatorCrossingLongitude	float64	[-165.05377369]
EquatorCrossingLongitude.2	float64	[170.2250609]
EquatorCrossingTime	STRING	21:45:30.874262
EquatorCrossingTime.2	STRING	23:24:24.096890
ExclusionGRingFlag	STRING	N
GRANULEBEGINNINGDATETIMEARRAY	STRING	2000-04-14T21:40:00.000000Z,2000-04-14T21:45:00.000000Z,2000-04-14T23:20:00.000000Z
GRANULEDAYNIGHTFLAGARRAY	STRING	Day,Day,Day
GRANULEENDINGDATETIMEARRAY	STRING	2000-04-14T21:45:00.000000Z,2000-04-14T21:50:00.000000Z,2000-04-14T23:25:00.000000Z

```
| GRANULENUMBERARRAY              | int32       | [262 263 282  -1  -1  -1  -1
-1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1                          |
|                                 |             |   -1  -1  -1  -1  -1  -1  -1
-1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1                           |
|                                 |             |   -1  -1  -1  -1  -1  -1  -1
-1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1                           |
|                                 |             |   -1  -1  -1  -1  -1  -1  -1
-1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1                           |
|                                 |             |   -1  -1  -1  -1  -1  -1  -1
-1  -1  -1  -1  -1  -1  -1  -1  -1  -1  -1                           |
|                                 |             |   -1  -1  -1  -1  -1  -1  -1
-1  -1  -1]                                                          |
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
| GRANULEPOINTERARRAY             | int32       | [ 0  1  2 -1 -1 -1 -1 -1 -1 -
1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1                             |
|                                 |             |  -1 -1 -1 -1 -1 -1 -1 -1 -1 -
1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1                             |
|                                 |             |  -1 -1 -1 -1 -1 -1 -1 -1 -1 -
1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1                             |
|                                 |             |  -1 -1 -1 -1 -1 -1 -1 -1 -1 -
1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1                             |
|                                 |             |  -1 -1 -1 -1]
|
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
| GRingPointLatitude              | float64     | [-6.83570031e-03
9.99897832e+00  9.99093096e+00  5.67994761e-06]
|
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
| GRingPointLongitude             | float64     | [-179.99995158  179.92847347
-169.92014729 -169.99173291]                                            |
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
| GRingPointSequenceNo            | int32       | [1 2 3 4]
|
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
| GeoAnyAbnormal                  | STRING      | False
|
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
| GeoEstMaxRMSError               | float64     | [50.]
|
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
| GlobalGridColumns               | int32       | [86400]
|
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
| GlobalGridRows                  | int32       | [43200]
|
+---------------------------------+-------------+-----------------------------
-------------------------------------------------------------------------+
```

GranuleID	STRING	MOD10A1.A2000105.h00v08.007.2026024052908.h5
HORIZONTALTILENUMBER	STRING	0
InputDataProducts	STRING	MOD10GA.A2000105.h00v08.007.2026024052633.h5
InstrumentName	STRING	Moderate Resolution Imaging Spectroradiometer
L2GCoverageCalculationMethod	STRING	volume
L2GFirstLayerSelectionCriteria	STRING	order of input pointer
L2GNumberOfOverlapGranules	uint32	[3]
LocalInputGranuleID	STRING	MOD10GA.A2000105.h00v08.007.2026024052633.h5
LocalVersionID	STRING	SCF V6.0.1
LongName	STRING	MODIS/Terra Snow Cover Daily L3 Global 500m SIN Grid
NADIRDATARESOLUTION	STRING	500m
NUMBEROFORBITS	int32	[2]
NumberOfInputGranules	int32	[3]

```
| NumberOfOverlapGranules          | int32       | [3]
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| ORBITNUMBERARRAY                 | int32       | [1726 1726 1727   -1   -1   -
1   -1   -1   -1   -1   -1   -1   -1   -1                             |
|                                  |             |    -1   -1   -1   -1   -1   -
1   -1   -1   -1   -1   -1   -1   -1   -1                             |
|                                  |             |    -1   -1   -1   -1   -1   -
1   -1   -1   -1   -1   -1   -1   -1   -1                             |
|                                  |             |    -1   -1   -1   -1   -1   -
1   -1   -1   -1   -1   -1   -1   -1   -1                             |
|                                  |             |    -1   -1   -1   -1   -1   -
1   -1   -1   -1   -1   -1   -1   -1   -1                             |
|                                  |             |    -1   -1   -1   -1   -1   -
1   -1   -1   -1   -1   -1   -1   -1   -1                             |
|                                  |             |    -1   -1   -1   -1   -1   -
1   -1   -1   -1   -1   -1   -1   -1   -1                             |
|                                  |             |    -1   -1]
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| OrbitNumber                      | int32       | [1726]
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| OrbitNumber.2                    | int32       | [1727]
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| PGEVersion                       | STRING      | 7.0.0
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| ParameterName                    | STRING      | NDSI_Snow_Cover
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| PlatformShortName                | STRING      | Terra
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| ProcessingCenter                 | STRING      | MODAPS
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| ProcessingDateTime               | STRING      | 2026-01-24T05:29:08.000Z
|
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| ProcessingEnvironment            | STRING      | Linux minion20082 5.4.0-1123-
fips #133-Ubuntu SMP Tue Jul 15 03:23:09 UTC 2025 x86_64              |
+---------------------------------+-------------+-----------------------------
----------------------------------------------------------------------+
| ProductionDateTime               | STRING      | 2026-01-24T05:31:54.000Z
|
```

QAPERCENTGOODQUALITY	STRING	0
QAPERCENTOTHERQUALITY	STRING	100
QAPercentCloudCover	int32	[0]
QAPercentMissingData	int32	[0]
RangeBeginningDate	STRING	2000-04-14
RangeBeginningTime	STRING	00:00:00
RangeEndingDate	STRING	2000-04-14
RangeEndingTime	STRING	23:59:59
ReprocessingActual	STRING	reprocessed
ReprocessingPlanned	STRING	further update is anticipated
SNOWCOVERPERCENT	STRING	0
SPSOParameters	STRING	none
ScienceQualityFlag	STRING	Not Investigated

ScienceQualityFlagExplanation	STRING	See https://landweb.modaps.eosdis.nasa.gov/prodqa?sat=Terra for the product Science Quality status.
ShortName	STRING	MOD10A1
TileID	STRING	51000008
VERTICALTILENUMBER	STRING	8
VersionID	int32	[7]
_AdditionalAttributeNames	STRING	QAPERCENTGOODQUALITY, QAPERCENTOTHERQUALITY, HORIZONTALTILENUMBER, VERTICALTILENUMBER, TileID, SNOWCOVERPERCENT, identifier_product_doi, identifier_product_doi_authority
creator_email	STRING	modis-ops@lists.nasa.gov
creator_name	STRING	MODAPS
creator_url	STRING	https://ladsweb.modaps.eosdis.nasa.gov
geospatial_lat_max	float64	[10.]

geospatial_lat_min	float64	[0.]
geospatial_lon_max	float64	[-169.99166665]
geospatial_lon_min	float64	[-179.99999998]
identifier_product_doi	STRING	10.5067/84NIJJLNHWTZ
institution	STRING	NASA Goddard Space Flight Center, LAADS
instrument	STRING	MODIS
keywords_vocabulary	STRING	NASA Global Change Master Directory (GCMD) Science Keywords
license	STRING	https://www.earthdata.nasa.gov/engage/open-data-services-software-policies/data-use-guidance
naming_authority	STRING	https://doi.org
platform	STRING	Terra
publisher_email	STRING	modis-ops@lists.nasa.gov
publisher_name	STRING	LAADS
publisher_url	STRING	https://ladsweb.modaps.eosdis.nasa.gov

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FILE STRUCTURE

```
├──── HDFEOS
│     ├──── ADDITIONAL
│     │     └──── FILE_ATTRIBUTES
│     └──── GRIDS
│         └──── MOD_Grid_Snow_500m
│             ├──── Data Fields
│             │     ├──── NDSI
│             │     ├──── NDSI_Snow_Cover
│             │     ├──── NDSI_Snow_Cover_Algorithm_Flags_QA
│             │     ├──── NDSI_Snow_Cover_Basic_QA
│             │     ├──── Projection
│             │     ├──── granule_pnt
│             │     └──── orbit_pnt
│             ├──── XDim
│             └──── YDim
└──── HDFEOS INFORMATION
      └──── StructMetadata.0
```

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SDS Layers

+===+

SDS Name: NDSI
Data Type: int16

This snow cover SDS is the best (first) raw NDSI from the input MOD10GA snow product.

Attribute Name	Data Type	Value
DIMENSION_LIST	COMPOUND	
_FillValue	int16	[-32768]
coordinates	STRING	/HDFEOS/GRIDS/MOD_Grid_Snow_500m/YDim /HDFEOS/GRIDS/MOD_Grid_Snow_500m/XDim
grid_mapping	STRING	Projection
long_name	STRING	Raw NDSI
scale_factor	float32	[0.0001]
units	STRING	none
valid_range	int16	[-10000 10000]

+===+

SDS Name: NDSI_Snow_Cover
Data Type: uint8

This NDSI snow cover represents the best (first) layer of input MOD10GA L2G lite data product.

Attribute Name	Data Type	Value
DIMENSION_LIST	COMPOUND	

```
Key               STRING       0-100=NDSI snow, 200=missing data, 201=no
decision, 211=night, 237=inland water, 239=ocean, 250=cloud, 254=detector
saturated, 255=fill
_FillValue        uint8        [255]
coordinates       STRING       /HDFEOS/GRIDS/MOD_Grid_Snow_500m/YDim
/HDFEOS/GRIDS/MOD_Grid_Snow_500m/XDim
grid_mapping      STRING       Projection
long_name         STRING       NDSI snow cover from best observation of the day
missing_value     uint8        [200]
units             STRING       none
valid_range       uint8        [  0 100]
+=====================================================================+

SDS Name: NDSI_Snow_Cover_Algorithm_Flags_QA
Data Type: uint8

Bit level QA values from the first (best) layer in input MOD10GA L2G lite snow
product.

Attribute Name    Data Type    Value
DIMENSION_LIST    COMPOUND
Key               STRING       bit on means:
                                          bit 0: inland water flag
                                          bit 1: low visible screen failed,
reversed snow detection
                                          bit 2: low NDSI screen failed,
reversed snow detection
                                          bit 3: combined temperature and
height screen failed, snow reversed because too warm and too low
                                                    This screen is also used
to flag a high elevation too warm snow detection,
                                                    in this case the snow
detection is not changed but this bit is set.
                                          bit 4: too high swir screen and
applied at two thresholds:
                                                    QA bit flag set if band6
TOA > 25% & band6 TOA <= 45%,
                                                    indicative of unusual snow
conditon, or snow commission error;
                                                    snow detection reversed if
band6 TOA > 45%
                                          bit 5: MOD35_L2 probably cloudy
                                          bit 6: MOD35_L2 probably clear
                                          bit 7: solar zenith screen,
indicates increased uncertainty in results
_FillValue        uint8        [255]
coordinates       STRING       /HDFEOS/GRIDS/MOD_Grid_Snow_500m/YDim
/HDFEOS/GRIDS/MOD_Grid_Snow_500m/XDim
format            STRING       bit flag
grid_mapping      STRING       Projection
long_name         STRING       NDSI snow cover algorithm bit flags
units             STRING       none
valid_range       uint8        [  0 254]
+=====================================================================+

SDS Name: NDSI_Snow_Cover_Basic_QA
```

Data Type: uint8

General QA value from the first (best) layer in input MOD10GA L2G lite snow product.

Attribute Name	Data Type	Value
DIMENSION_LIST	COMPOUND	
Key	STRING	0=best, 1=good, 2=ok, 3=poor-not used, 4=other-not used, 211=night, 239=ocean, 255=unusable L1B data or no data
_FillValue	uint8	[255]
coordinates	STRING	/HDFEOS/GRIDS/MOD_Grid_Snow_500m/YDim /HDFEOS/GRIDS/MOD_Grid_Snow_500m/XDim
grid_mapping	STRING	Projection
long_name	STRING	NDSI snow cover general quality value
units	STRING	none
valid_range	uint8	[0 4]

SDS Name: Projection
Data Type: int32

Attribute Name	Data Type	Value
earth_radius	float64	[6371007.181]
false_easting	float64	[0.]
false_northing	float64	[0.]
grid_mapping_name	STRING	sinusoidal
longitude_of_central_meridian	float64	[0.]

SDS Name: granule_pnt
Data Type: uint8

The granule_pnt layer from the first (best)layer of input MOD10GA snow product. This can be used to determine which input L2 granules contributed to this best (first) layer from input L2G lite snow product.

Attribute Name	Data Type	Value
DIMENSION_LIST	COMPOUND	
_FillValue	uint8	[255]
coordinates	STRING	/HDFEOS/GRIDS/MOD_Grid_Snow_500m/YDim /HDFEOS/GRIDS/MOD_Grid_Snow_500m/XDim
grid_mapping	STRING	Projection
long_name	STRING	Granule pointer for observation
units	STRING	none
valid_range	uint8	[0 254]

SDS Name: orbit_pnt
Data Type: int8

The orbit_pnt layer from the first (best) layer of input MOD10GA snow product. This can be used to determine which input L2 orbits contributed to this best (first) layer from input L2G lite snow product.

Attribute Name	Data Type	Value
DIMENSION_LIST	COMPOUND	

```
_FillValue        int8         [-1]
coordinates       STRING       /HDFEOS/GRIDS/MOD_Grid_Snow_500m/YDim
/HDFEOS/GRIDS/MOD_Grid_Snow_500m/XDim
grid_mapping      STRING       Projection
long_name         STRING       Orbit pointer for observation
units             STRING       none
valid_range       int8         [ 0 15]
+=====================================================================+

SDS Name: XDim
Data Type: float64
Attribute Name         Data Type    Value
CLASS                  STRING       DIMENSION_SCALE
NAME                   STRING       x
REFERENCE_LIST         COMPOUND
coverage_content_type  STRING       coordinate
long_name              STRING       x coordinate of projection
standard_name          STRING       projection_x_coordinate
units                  STRING       m
+=====================================================================+

SDS Name: YDim
Data Type: float64
Attribute Name         Data Type    Value
CLASS                  STRING       DIMENSION_SCALE
NAME                   STRING       y
REFERENCE_LIST         COMPOUND
coverage_content_type  STRING       coordinate
long_name              STRING       y coordinate of projection
standard_name          STRING       projection_y_coordinate
units                  STRING       m

+=====================================================================+

STRUCTURE METADATA

GROUP=SwathStructure
END_GROUP=SwathStructure
GROUP=GridStructure
       GROUP=GRID_1
              GridName="MOD_Grid_Snow_500m"
              XDim=2400
              YDim=2400
              UpperLeftPointMtrs=(-20015109.354000,1111950.519667)
              LowerRightMtrs=(-18903158.834333,0.000000)
              GridOrigin=HE5_HDFE_GD_UL
              Projection=HE5_GCTP_SNSOID
              ProjParams=(6371007.181000,0,0,0,0,0,0,0,0,0,0,0,0,0)
              SphereCode=-1
              GROUP=Dimension
                     OBJECT=Dimension_1
                            DimensionName="XDim"
                            Size=2400
                     END_OBJECT=Dimension_1
                     OBJECT=Dimension_2
                            DimensionName="YDim"
```

```
                Size=2400
        END_OBJECT=Dimension_2
        OBJECT=Dimension_3
                DimensionName="dimofone"
                Size=1
        END_OBJECT=Dimension_3
END_GROUP=Dimension
GROUP=DataField
        OBJECT=DataField_1
                DataFieldName="NDSI_Snow_Cover"
                DataType=H5T_NATIVE_UCHAR
                DimList=("YDim","XDim")
                MaxdimList=("YDim","XDim")
                CompressionType=HE5_HDFE_COMP_DEFLATE
                DeflateLevel=9
                TilingDimensions=(30,2400)
        END_OBJECT=DataField_1
        OBJECT=DataField_2
                DataFieldName="NDSI_Snow_Cover_Basic_QA"
                DataType=H5T_NATIVE_UCHAR
                DimList=("YDim","XDim")
                MaxdimList=("YDim","XDim")
        END_OBJECT=DataField_2
        OBJECT=DataField_3
                DataFieldName="NDSI_Snow_Cover_Algorithm_Flags_QA"
                DataType=H5T_NATIVE_UCHAR
                DimList=("YDim","XDim")
                MaxdimList=("YDim","XDim")
        END_OBJECT=DataField_3
        OBJECT=DataField_4
                DataFieldName="NDSI"
                DataType=H5T_NATIVE_SHORT
                DimList=("YDim","XDim")
                MaxdimList=("YDim","XDim")
        END_OBJECT=DataField_4
        OBJECT=DataField_5
                DataFieldName="orbit_pnt"
                DataType=H5T_NATIVE_SCHAR
                DimList=("YDim","XDim")
                MaxdimList=("YDim","XDim")
        END_OBJECT=DataField_5
        OBJECT=DataField_6
                DataFieldName="granule_pnt"
                DataType=H5T_NATIVE_UCHAR
                DimList=("YDim","XDim")
                MaxdimList=("YDim","XDim")
        END_OBJECT=DataField_6
        OBJECT=DataField_7
                DataFieldName="Projection"
                DataType=H5T_NATIVE_INT
                DimList=("dimofone")
                MaxdimList=("dimofone")
        END_OBJECT=DataField_7
END_GROUP=DataField
GROUP=MergedFields
END_GROUP=MergedFields
```

```
      END_GROUP=GRID_1
END_GROUP=GridStructure
GROUP=PointStructure
END_GROUP=PointStructure
GROUP=ZaStructure
END_GROUP=ZaStructure
END
```