MODIS/Terra Sea Ice Extent and IST Daily L3 Global 4km EASE-Grid Day, Version 61

USER GUIDE

How to Cite These Data

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

Hall, D. K. and G. Riggs. 2021. *MODIS/Terra Sea Ice Extent and IST Daily L3 Global 4km EASE-Grid Day, Version 61*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/MODIS/MOD29E1D.061. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/MOD29E1D

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This data set consists of sea ice extent and ice surface temperature (IST), generated by remapping 1 km resolution data from MOD29P1D to a 4 km resolution grid, for both the Northern and Southern Hemispheres. The gridded input observation nearest the center of the output grid cell is assigned to that grid cell. As such, approximately every fourth input grid cell is mapped to the output grid. No QA data is provided. The purpose of this data set is to composite subsampled MOD29P1D data and provide users with a general view of hemispheric sea ice. The Scientific Data Sets (SDSs) included in this product are listed in Table 1 and sample images of the data are provided in Figure 1.

The terms "Version 61" and "Collection 6.1" are used interchangeably in reference to this release of MODIS data.

1.1 Parameters

Table 1. SDS Details

Parameter	Description	Values
Northern Hemisphere group: MOD_Grid_Seaice_4km_North		
`Sea_Ice_by_Reflectance_NP`	Sea ice extent map stored as coded integers[1]. Pixels are reported as sea ice, ocean, cloud, land, inland water, or other conditions (e.g. missing data). Daylight only.	0: missing 1: no decision 11: night 25: land 37: inland water 39: ocean 50: cloud 200: sea ice 253: no input tile expected 254: non-production mask
`Ice_Surface_Temperature_NP`	IST is stored as calibrated data (scaled integers). Use the equation below to convert to K: $IST = scale\_factor * (calibrated\_data - add\_offset)$ where $scale\_factor = 0.01$ and $add\_offset = 0.0$.[2] The valid range for ISTs is 223.20 K to 313.20 K.	0.0: missing 1.0: no decision 5.0: non-production mask 7.0: tile fill 8.0: no input tile expected 25.0: land 37.0: inland water 50.0: cloud 243-273: expected range of IST calibrated data values

Parameter	Description	Values
Southern Hemisphere group: MOD_Grid_Seaice_4km_South		
`Sea_Ice_by_Reflectance_SP`	Sea ice extent map stored as coded integers[1]. Pixels are reported as sea ice, ocean, cloud, land, inland water, or other conditions (e.g. missing data). Daylight only.	0: missing 1: no decision 11: night 25: land 37: inland water 39: ocean 50: cloud 200: sea ice 253: no input tile expected 254: non-production mask
`Ice_Surface_Temperature_SP`	IST is stored as calibrated data (scaled integers). Use the equation below to convert to K: $IST = scale\_factor * (calibrated\_data - add\_offset)$ where $scale\_factor = 0.01$ and $add\_offset = 0.0$.[2] The valid range for ISTs is 223.20 K to 313.20 K.	0.0: missing 1.0: no decision 5.0: non-production mask 7.0: tile fill 8.0: no input tile expected 25.0: land 37.0: inland water 50.0: cloud 243-273: expected range of IST calibrated data values

[1] Coded integer keys are stored as Local Attributes with each SDS.

[2] Values for $scale\_factor$ and add_offset are also stored as Local Attributes with the IST SDSs.

1.2 Sample Image

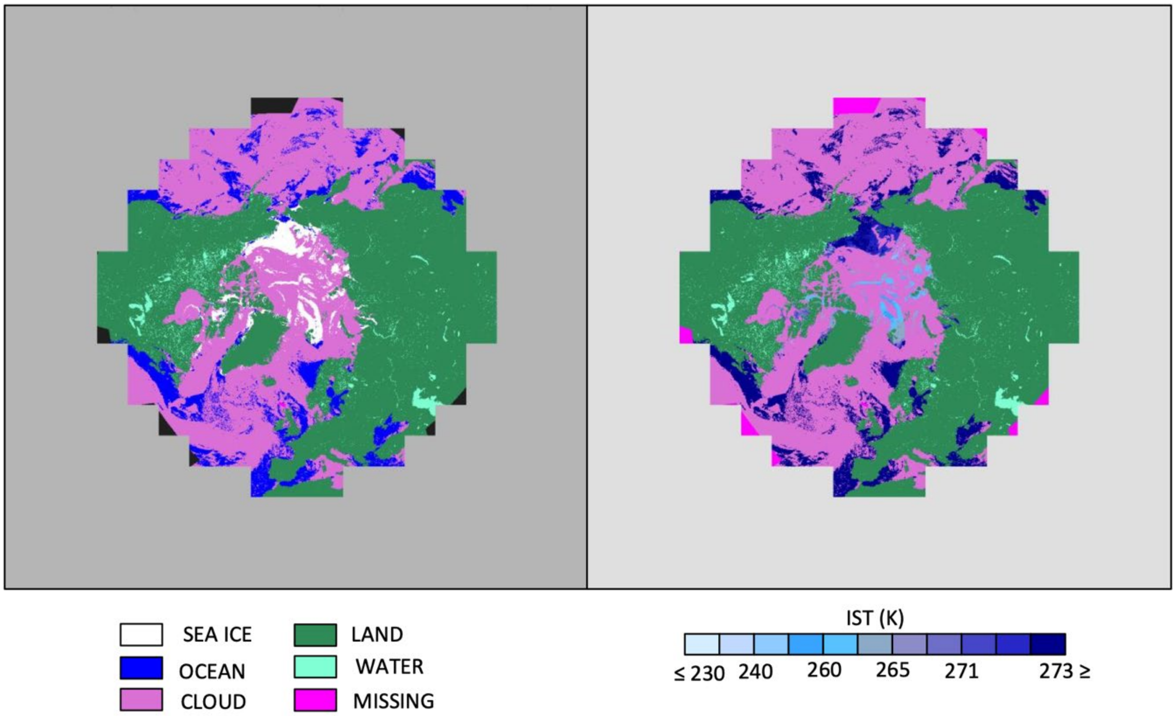

Figure 1. This figure shows MOD29E1D 4 km sea ice extent (left) and IST (right) for the Northern Hemisphere, acquired on 23 May 2002.

1.3 File Information

1.3.1 File Format

Data are provided in HDF-EOS2 format and are stored as 8-bit unsigned integers (ISTs are stored as 16-bit). For software and more information, visit the HDF-EOS website.

1.3.2 File Contents

As shown in Figure 2, each data file includes two data groups (one for Northern Hemisphere data, another for Southern Hemisphere data), each containing two data fields (Ice_Surface_Temperature and Sea_Ice_by_Reflectance), and three metadata fields (ArchiveMetadata.0, CoreMetadata.0, and StructMetadata.0).

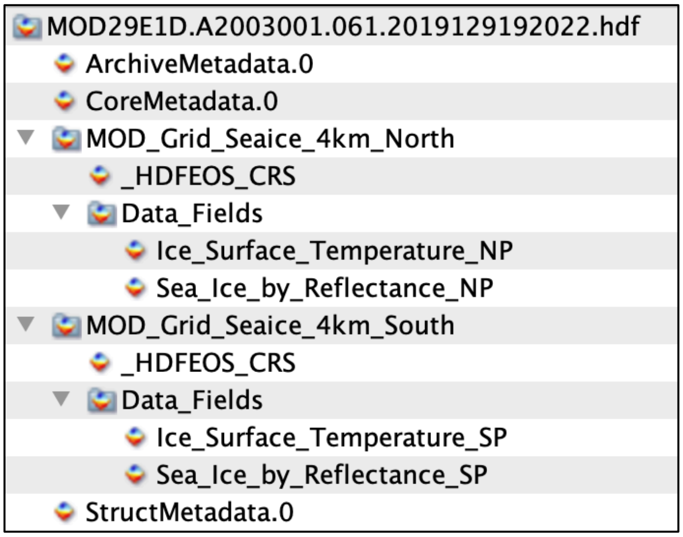

Figure 2. This figure shows the MOD29P1D fields included in each data file as displayed with Panoply software.

1.3.3 Ancillary Files

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

1.3.4 Naming Convention

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

File naming convention:

`MOD[PID].A[YYYY][DDD].[VVV].[yyyy][ddd][hhmmss].hdf`

Table 2. File Name Variables

`MOD`	MODIS/Terra
`PID`	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 GMT
`.hdf`	HDF-EOS formatted data file

File name example:

`MOD29E1D.A2003001.061.2019129192022.hdf`

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-EOS data file has a corresponding XML metadata file (.xml), which contains some of the same internal metadata as the HDF-EOS file plus additional information regarding user support, archiving, and granule-specific post-production. Refer to the MODIS Sea Ice Products User Guide to Collection 6.1 for additional information.

1.4 Spatial Information

1.4.1 Coverage

Coverage is global, however only ocean pixels are evaluated for sea ice.

1.4.2 Resolution

The gridded resolution is approximately 4 km.

1.4.3 Geolocation

This product is provided in the original EASE-Grid Lambert Azimuthal Equal Area (EASE-Grid) map projection. Data files contain separate 4501 x 4501 arrays for the Northern and Southern Hemisphere, centered on the North Pole and South Pole.

See the MODIS Land team's MODIS Grids Web page for information about all the projections and grids used for MODIS data sets. For a complete description of EASE-Grid, see NSIDC's EASE-Grid Data | Overview page.

Table 3 and Table 4 provide geolocation information for this data set.

Table 3. Projection Details

Region	Northern Hemisphere	Southern Hemisphere
Geographic coordinate system	N/A	N/A
Projected coordinate system	NSIDC EASE-Grid North	NSIDC EASE-Grid South
Longitude of true origin	0°	0°
Latitude of true origin	90°	-90°
Scale factor at longitude of true origin	N/A	N/A
Datum	N/A	N/A
Ellipsoid/spheroid	International 1924 Authalic Sphere	International 1924 Authalic Sphere

Units	Meter	Meter
False easting	0°	0°
False northing	0°	0°
EPSG code	3408	3409
PROJ4 string	+proj=laea +lat_0=90 +lon_0=0 +x_0=0 +y_0=0 +a=6371228 +b=6371228 +units=m +no_defs	+proj=laea +lat_0=-90 +lon_0=0 +x_0=0 +y_0=0 +a=6371228 +b=6371228 +units=m +no_defs
Reference	http://epsg.io/3408	http://epsg.io/3409

Table 4. Grid Details

Region	**Northern Hemisphere**	**Southern Hemisphere**
Grid cell size (x, y pixel dimensions)	4 km	4 km
Number of rows	4501	4501
Number of columns	4501	4501
Nominal gridded resolution	4 km	4 km
Grid rotation	N/A	N/A
Geolocated upper left point (m)	-9058902.1845(x), 9058902.1845(y)	-9058902.1845(x), 9058902.1845(y)
Geolocated lower right point (m)	9058902.1845(x), -9058902.1845(y)	9058902.1845(x), -9058902.1845(y)

1.5 Temporal Information

1.5.1 Coverage

The temporal coverage of this data set extends from 24 February 2000 to the present. Over the course of the Terra mission a number of anomalies 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.

1.5.2 Resolution

Daily

2 DATA ACQUISITION AND PROCESSING

2.1 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 will continue to drift and is expected to reach a 10:15 AM MLT in October 2022. At that time, the flight operations team will have Terra exit the Earth Sciences Constellation and lower Terra to an altitude of 694 km by performing two retrograde maneuvers. MLT will continue to drift after these maneuvers, reaching 9:00 AM around December 2025. Terra MODIS will remain operational and generate the full suite of products until the end of the mission in December 2025.

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).

Details on the impact of the Constellation Exit on the quality of the product are being compiled and will be posted when available.

2.2 Source and Processing

This data set is generated by mapping the *MODIS/Terra Sea Ice Extent Daily L3 Global 1km EASE-Grid Day* (MOD29P1D, version 61) product into a polar input grid at 1 km resolution. The input grid is then mapped to an approximately 4 km resolution output grid modeled on the original EASE-Grid. The gridded input observation nearest the center of an output grid cell is assigned as the output value for that grid cell. Approximately every fourth input grid cell is mapped into a sequential output grid cell.

Refer to the MOD29P1D User Guide for information on the daily sea ice processing algorithm. Users seeking a more detailed description of these and other MODIS Sea Ice products should consult the MODIS Sea Ice Products User Guide to Collection 6.1 and the Algorithm Theoretical Basis Document (Hall et al., 2001).

2.2.1 Error Sources

As with any upper level product, anomalies present in the input data may carry through to the output product. Refer to the MOD29P1D User Guide for information on error sources relevant to this product. In addition, sea ice and IST features may sometimes lack continuity, especially in the polar summer season. This can occur because pixels are obtained from different swaths separated in time, during which sea ice and clouds may have moved.

2.3 Quality Assessment

QA data has been omitted from this data set because it aims to provide a general view of hemispheric sea ice by compositing subsampled MOD29P1D data.

2.4 Instrumentation

2.4.1 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 6 contains the instruments' technical specifications:

Table 5. MODIS Technical Specifications

Variable	Description
Orbit	705 km altitude, 10:30 A.M. descending node (Terra), sun-synchronous, near-polar, circular
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
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

Variable	Description
Spatial Resolution	250 m (bands 1-2) 500 m (bands 3-7) 1000 m (bands (8-36)
Design Life	6 years

2.4.2 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 short wave 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.

For additional details about the MODIS instruments, see NASA's MODIS | About Web page.

3 SOFTWARE AND TOOLS

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

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.
- What is HDF-EOS? an NSIDC FAQ
- The MODIS Conversion Toolkit (MCTK) plug-in for ENVI can ingest, process, and georeference every known MODIS data set, 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 6.1 data, including known problems, production schedules, and future plans:

- The MODIS Snow and Sea Ice Global Mapping Project
- NASA LDOPE | MODIS/VIIRS Land Product Quality Assessment
- MODIS Land Team Validation | Status for Snow Cover/Sea Ice (MOD10/29)

5 CONTACTS AND ACKNOWLEDGMENTS

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6 REFERENCES

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7 DOCUMENT INFORMATION

7.1 Publication Date

March 2021

7.2 Date Last Updated

December 2021