MODIS Sea Ice Products User Guide

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Introduction

The MODIS sea ice products are created as a sequence of products beginning with a swath (scene) and progressing, through spatial and temporal transformations, to a daily product. The algorithms and data content of these sea ice products are briefly described in this guide with the purpose of providing a user with sufficient information about the content and structure of the data files to enable the user to access and use the data. Overviews of the file format and sequence of MODIS sea ice products are given first. Descriptions of each algorithm and product content are given in following sections. World Wide Web sites and documents related to the sea ice products are listed in the last two sections.

File Format of Sea Ice Products

The MODIS sea ice products are archived in Hierarchical Data Format - Earth Observing System (HDF-EOS) format files. **HDF**, developed by the National Center for Supercomputer Applications (NCSA), is the standard archive format for EOS Data Information System (EOSDIS) products. The sea ice product files contain global attributes (metadata) and scientific data sets (SDSs) (arrays) with local attributes. Unique in HDF-EOS data files is the use of HDF features to create point, swath, and grid structures to support geolocation and mapping of data. These structures (Vgroups and Vdata) provide geolocation relationships between data in an SDS and geographic coordinates (latitude and longitude or map projections) to support mapping the data. Attributes (metadata), global and local, provide various information about the data. Users unfamiliar with HDF and HDF-EOS formats may wish to consult Web sites listed in the **Related Web Sites** section for more information.

Sea ice data product files contain three EOS Data Information System (EOSDIS) Core System (ECS) global attributes also referred to as metadata by ECS. These ECS global attributes; *CoreMetadata.0,*

ArchiveMetadata.0 and *StructMetadata.0* contain information relevant to production, archiving, user services, geolocation and analysis of data. The ECS global attributes are written in parameter value language (PVL) and are stored as a character string. Metadata and values are stored as objects within the PVL string. Results of the sea ice algorithms, e.g. sea ice extent, are stored as SDSs with local attributes. Local attributes describe data in an SDS. Detailed descriptions of each sea ice product are given in following sections.

Products may also contain product specific attributes (PSAs) defined by the product developers as part of the ECS *CoreMetadata.0* attribute. Geolocation and gridding relationships between HDF-EOS point, swath, and grid structures and the data are contained in the ECS global attribute *StructuralMetadata.0.* A separate file containing metadata will accompany data products ordered from a DAAC. That metadata file will have a .met extension and is written in PVL. The .met file contains some of the same metadata as in the product file but also has other information regarding archiving and user support services as well as some post production quality assurance (QA) information relevant to the granule ordered. The post production QA metadata may or may not be present depending on whether or not the data granule has been investigated. The .met file should be examined to determine if post production QA has been applied to the granule. (The Quality Assurance sections of this guide provide information on post production QA.)

The data products were generated in the MODIS Adaptive Processing System (MODAPS) using the HDF-EOS toolkit, Science Data Processing (SDP) Toolkit, HDF API and the C programming language. Various software packages, commercial and public domain, are capable of accessing the HDF-EOS files.

Sequence of Sea Ice Products

Sea ice data products are produced as a series of three products. The sequence begins as a swath (scene) at a nominal pixel spatial resolution of 1 km and a nominal swath coverage of 2330 km (cross track) by 2030 km (along track, about five minutes of MODIS scans) in areal coverage. A summarized listing of the sequence of products is given in Table 1. Products in EOSDIS are labeled as Earth Science Data Type (ESDT), the ESDT label "ShortName" is used to identify the sea ice data products. Except for the initial sea ice product, MOD29, each sea ice product in the sequence is built from the previous sea ice product. These sea ice products are identified, in part, by product levels in EOSDIS that indicate what spatial and temporal processing has been applied to the data.

Data product levels briefly described: Level 1B (L1B) is a swath (scene) of MODIS data geolocated to latitude and longitude centers of 1 km resolution pixels. A level-2 (L2) product is a geophysical product that remains in latitude and longitude orientation; it has not been temporally or spatially manipulated. A level-2G

(L2G) product is a gridded format of a map projection. At L2G the data products are referred to as tiles, each tile being a piece, e.g. 10° x 10° area, of a map projection. Level-2 data products are gridded into L2G tiles by mapping the L2 pixels into cells of a tile in the map projection grid. The L2G algorithm creates a gridded product necessary for the level 3 products. A level-3 (L3) product is a geophysical product that has been temporally and or spatially manipulated, and is usually in a gridded map projection format.

Brief descriptions of the sea ice data products are given here to give perspective to the sequence. Expanded descriptions of the sea ice products are given in following sections.

The first product, MOD29, is a sea ice extent and ice surface temperature map at 1 km spatial resolution for a swath. The sea ice map is the result of the algorithm identifying sea ice and other features in the scene. Geolocation data (latitude and longitude) at 5 km resolution are stored in the product. The L2G product is a multidimensional data product created by mapping the pixels from the MOD29 products for a day to their Earth locations on the Lambert azimuthal equal area or EASE-Grid projection, thus multiple observations, i.e. pixels, covering a geographic location (cell) in the tile are "stacked" on one another. Two EASE-Grid projections, Northern and Southern Hemispheres are used for mapping. Information on how the pixels were mapped to the cells is stored in a pointer product associated with the L2G product. The third product is daily sea ice cover at 1 km spatial resolution. From the multiple observations in a cell of the L2G product the observation selected for the day is the one that has the highest score from a scoring algorithm based on solar elevation, observation coverage in a cell and distance from nadir. For observations obtained at night, when only thermal data is acquired, solar elevation is omitted from the scoring algorithm.

Content of sea ice data products is different between day and night because MODIS visible data are not acquired when the sensor is observing the surface in darkness. Thermal data are acquired day and night. In L2 swaths that were acquired in daylight or that observed a mix of day and night contain SDSs based on reflective and thermal data. In L2 swaths that were acquired in night mode, only the SDSs based on thermal data are included in the product. Sea ice products are split into day and night products at L2G and L3. The split was made to reduce file size, L2G files could exceed the 2 Gbyte size limit over the poles because data from 1 – 14 orbits could be contained in the file. The ESDT names of the L2G and L3 products (Table 1) indicate if the data are from day or night. The naming convention for sea ice ESDT products is;

MOD29*pto*
Where,

p – is the projection

P – polar
t – is the level and/or time period covered
G – level 2G
1 - L3 daily
o – day or night
N – night
D – day

Table 1. Summary of the MODIS sea ice data products.

Earth Science Data Type (ESDT)	Product Level	Nominal Data Array Dimensions	Spatial Resolution	Temporal Resolution	Map Projection
MOD29	L2	1354 by 2030	1 km	swath (scene)	lat, lon referenced
MOD29PGD	L2G	1200 by 1200	1 km	day of multiple coincident swaths	EASE-GRID
MOD29PGN	L2G	1200 by 1200	1 km	day of multiple coincident swaths	EASE-GRID
MOD29P1D	L3	1200 by 1200	1 km	day	EASE-GRID
MOD29P1N	L3	1200 by 1200	1 km	day	EASE-GRID

MOD29 Sea Ice Product

This product is generated using the MODIS sensor radiance data product (MOD021KM), the geolocation product (MOD03), and the cloud mask product (MOD35_L2). The output file contains sea ice extent SDS, ice surface temperature (IST) SDS, quality assurance (QA) SDSs, sea ice extent based on IST SDS and a sea ice extent by combined reflectance and IST extents SDS, latitude and longitude SDSs, local attributes, and global attributes. The sea ice extent algorithm identifies sea ice-covered oceans by reflectance characteristics; it also estimates ice surface temperature (IST). For complete global

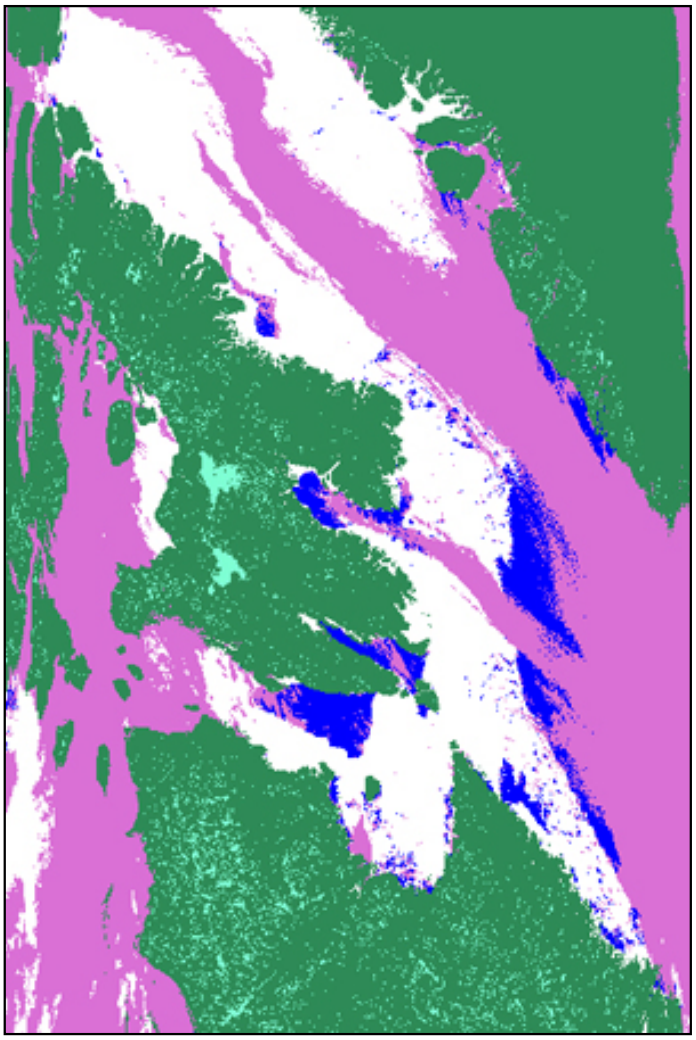

Figure 1. Sea ice extent displayed in this image of Northeastern Canada and Baffin Bay, acquired from the Terra MODIS instrument on the 5th of May 2001.

coverage the MOD29 sea ice product is generated for all swaths acquired during a day, 24 hours. Swaths that were acquired completely in night mode contain only the temperature based SDSs.

A colorized sea ice extent map generated from MODIS data by the sea ice algorithm is exhibited in Figure 1 *(to be added soon)*. The sea ice extent algorithm and data product contents are described in the following sections.

Algorithm Description

A brief sketch of the sea ice algorithm is described here for the purpose of aiding the user in understanding and interpreting the data product.

Analysis for sea ice in a MODIS swath is constrained to pixels that are of oceans, have nominal radiance values and are not obstructed by clouds. Data inputs to the sea ice algorithm are listed in Table 2.

Clouds are masked with the MODIS Cloud Mask data product (MOD35_L2). Initially only the unobstructed field-of-view flag from MOD35_L2 is used to mask clouds. MOD35_L2 contains a great amount of data on the results of the processing paths and cloud tests applied within the MODIS cloud-clearing algorithm. Investigative research on MOD35_L2 cloud detection performance to determine how better to use the cloud mask data continues.

Masking of land and inland water bodies is done with the 1 km resolution land/water mask, contained in the MODIS geolocation product (MOD03).

Table 2. MODIS data product inputs to the MODIS sea ice algorithm.

ESDT	Long Name	Data Used
MOD021KM	MODIS Level 1B Calibrated and Geolocated Radiances	MODIS bands: 1 (0.645 µm) 2 (0.865 µm) 4 (0.555 µm) 6 (1.640 µm) 31 (11.03 µm) 32 (12.02 µm)
MOD03	MODIS Geolocation	Land/Water Mask Solar Zenith Angles Sensor Zenith Angles Latitude Longitude
MOD35_L2	MODIS Cloud Mask	Unobstructed Field of View Flag Day/Night Flag

Sea ice detection is achieved through the use of grouped criteria tests for sea ice reflectance characteristics in the visible and near-infrared regions. Criteria for sea ice is that a pixel has a normalized difference snow index (NDSI), (band 4-band 6) / (band 4 + band 6) greater than 0.4 and visible reflectance (band 2) greater than 0.11 and band 1 reflectance greater than 0.10. If a pixel passes this group of criteria tests it is identified as sea ice in the data product.

Intermediate checks for theoretical bounding of reflectance data and the NDSI ratio are made in the algorithm. In theory, reflectance values should lie within the 0-100% range and the NDSI ratio should lie within the -1.0 to +1.0 range. However, the test for sea ice is done regardless of violations of these limits and a quality flag is set in the quality assurance data array to indicate the occurrence.

Ice surface temperature (IST) is estimated with a split-window technique using MODIS bands 31 and 32. Coefficients for the IST equation were derived by J. Key using MODIS spectral response functions and radiative transfer calculations. Sets of coefficients are implemented for the northern and southern hemispheres and for temperature ranges. Coefficients are reported as local attributes with the IST SDS.

IST = IST = a +bT11 + c(T11-T12) +d[(T11-T12)(sec(q)-1)]

where T11 is brightness temperature at 11.03 mm
T12 is brightness temperature at12.02 mm
q is sensor scan angle
a,b,c,d are regression coefficients.

A different set of a, b, c, and d coefficients is used for each of three temperature ranges in the Northern and Southern Hemispheres separately.

A basic assumption is made that all the input data products will be available and that the quality of the data will be acceptable. That assumption may be violated, occasionally, so catches for anomalous data have been, and are being built into the algorithm during testing. Possibly the most common anomaly is that some input data, e.g. a scan line of MODIS data is missing. In the case of missing data, the sea ice algorithm identifies the data as missing in the output product. No action is taken in the algorithm to make an analysis for missing data. If other anomalous conditions occur with the input data, the sea ice algorithm makes no sea ice decision for that pixel, except for some expected anomalous conditions where a value indicating the source of the anomaly is written, and moves to the next pixel.

Quality Assurance

Indicators of quality are given in metadata objects in the *CoreMetadata.0* global attribute and in quality assurance (QA) SDSs, generated during production, or in post-product scientific and quality checks of the data product. QA metadata objects in the *CoreMetadata.0* global attribute are the AutomaticQualityFlag and the ScienceQualityFlag and their corresponding explanations. The AutomaticQualityFlag is set according to rules based on data conditions encountered during a run of the sea ice algorithm. Setting of this QA flag is fully automated. The rules used to set it are liberal; nearly all of the data or intermediate calculations would have to be anomalous for it to be set to "Failed". Typically, it will be set to "Passed" or "Suspect". "Suspect" means that a high percentage of the data was found to be anomalous and that further analysis should be done to determine the source. The ScienceQualityFlag and ScienceQualityFlagExplanantion are set post production either after an automated QA program is run on the data product or after the data product is inspected by a qualified sea ice investigator. Content and explanation of these flags are dynamic so should always be examined if present. A sampling of products will be inspected. Sampling may be random, in support of field campaigns, or event driven.

The QA SDSs in the data product provide additional information on algorithm results for each pixel. The QA

SDS data are stored as bit flags in the SDS. This QA information can be extracted by reading bits of the byte. The purpose of the QA SDS is to give the user information on algorithm results for each pixel that can be viewed in a spatial context. The QA information tells if algorithm results were nominal, abnormal, or if other defined conditions were encountered for a pixel. The QA information should be used to help determine the usefulness of the sea ice data for a user's needs. Predefined HDF local attributes for the QA SDS are listed in Table 3. Custom local attributes are written with each QA SDS. The sea ice extent QA SDS corresponding to Figure 1 is shown in Figure 4 [temporarily unavailable]. Shown are bit masks of the pixels that had nominal QA, were cloud obscured, or for which abnormal conditions were detected.

Scientific Data Sets

Results of the sea ice algorithm are stored in six or three SDSs in the product. The number of SDSs varies between swaths that have day or either day and night data, or only night, i.e. only thermal data. There are also two SDSs of geolocation data, in addition to the algorithm result data, that are in every product. Swaths that have day data in them have eight SDSs. Swaths that have only thermal data have five SDSs. Each of the SDSs are described in the following subsections.

Common to all the SDSs is the use of HDF-predefined local attributes to provide descriptions of the data in the SDS. The HDF-predefined local attributes are listed in Table 3. Some software packages make use of the standardized HDF-predefined local attributes. Unless otherwise noted in the descriptions of each SDS in following subsections all these attributes, with the exception of “Calibration”, are written for each SDS.

Table 3. HDF-predefined local attributes for SDSs in the MOD29 product.

Attribute Name	**Reserved Label(s)**	**Definition**	**Sample Value**
Label	long_name	Long Name of the SDS	Sea ice by reflective characteristics
Unit	units	SI units of the data, if any	none
Format	format	How the data should be viewed, Fortran format notation	I3
Coordinate System	coordsys	Coordinate system to use for the data	cartesian
Range	valid_range	Max and min values within a selected data range	0-254

Fill Value	_FillValue	Data used to fill gaps in the swath	255
Calibration	scale_factor scale_factor_err add_offset add_offset_err calibrated_nt	Used if data is stored in calibrated form	

Latitude and Longitude SDSs

Coarse resolution (5 km) latitude and longitude data for geolocating the sea ice data are located in the “Latitude” and “Longitude” SDSs. The latitude and longitude data correspond to a center pixel of a 5 km by 5 km block of pixels in the sea ice SDSs. The mapping relationship of geolocation data to the sea ice data is specified in the global attribute *StructMetadata.0.* Mapping relationship was created by the HDF-EOS SDPTK toolkit during production. Geolocation data is mapped to the sea ice data with an offset = 5 and increment = 10. The first element (1,1) in the geolocation SDSs corresponds to element (5,5) in “Sea Ice by reflective characteristics” SDS; the algorithm then increments by 10 in the cross-track or along-track direction to map geolocation data to the SDS.

Local Attributes

Local attributes of the “Latitude” and “Longitude” SDS are those listed in Table 3 except, “coordsys” and “format” which are not written, with the addition of the local attribute listed in Table 4.

Table 4. Local Attributes for the “Latitude” and “Longitude” SDSs.

Attribute Name	**Definition**	**Sample Value**
source	Where the data came from	MOD03 geolocation product; data read from center pixel in 5 km box.

Sea Ice by Reflective Characteristics SDS

Data are stored as coded integers in the "Sea Ice by reflective characteristics" SDS of the HDF-EOS product file. The sea ice algorithm identifies pixels as being sea ice, ocean, cloud, land, inland water, or other condition. The conditions identified by the algorithm are listed in Table 5. Table 5 is the interpretation key to the coded integers, and is stored as the local attribute "Key:".

Table 5. Interpretation key for MOD29 “Sea Ice by reflective characteristics” SDS.

Integer Value	Meaning
254	Saturated MODIS sensor detector
200	Sea ice
50	Cloud Obscured
39	Ocean
37	Inland Water
25	Land--no sea ice detected
11	Darkness, terminator or polar
1	No Decision
0	Sensor Data Missing

Local Attributes

Archived with the "Sea Ice by reflective characteristics" SDS are local attributes that describe the data. HDF predefined local attributes (Table 3) describe characteristics of the data, and custom local attributes (Table 6) provide some information about the data. An exception in the use of HDF-predefined local attributes is that "Calibration" is not used because the sea ice extent data are not stored in calibrated format.

Custom local attributes for the "Sea Ice by reflective characteristics" SDS are listed and described in Table 6.

Table 6. Local Attributes for the “Sea Ice by reflective characteristics” SDS.

Attribute Name	Definition	Sample Value
Key:	Key to meaning of data in the SDS	*see Table 5*
Nadir_data_resolution	Nominal spatial resolution of the pixels at nadir	1 km
Valid EV Obs Band 2 (%)	The percentage[A] of valid observations from Level 1B in Band 2 in the swath. (0.0-100.0)	100.0

Valid EV Obs Band 4 (%)	The percentage[A] of valid observations from Level 1B in Band 4 in the swath. (0.0-100.0)	100.0
Valid EV Obs Band 6 (%)	The percentage[A] of valid observations from Level 1B in Band 6 in the swath. (0.0-100.0)	100.0
Saturated EV Obs Band 1 (%)	The percentage[A] of saturated observations from Level 1B in Band 1 in the swath. (0.0-100.0)	0.342
Saturated EV Obs Band 2 (%)	The percentage[A] of Saturated observations from Level 1B in Band 2 in the swath. (0.0-100.0)	0.287
Saturated EV Obs Band 4 (%)	The percentage[A] of saturated observations from Level 1B in Band 4 in the swath. (0.0-100.0)	0.779
Saturated EV Obs Band 6 (%)	The percentage[A] of saturated observations from Level 1B in Band 6 in the swath. (0.0-100.0)	0.698
[A] These percentages are based on the total number of pixels in the swath (x_dim*y_dim).		

Sea Ice by Reflective Pixel QA SDS

The quality status of the algorithm run for each pixel is stored in this SDS. The purpose of the QA SDS is to give the user information on algorithm results for each pixel that can be viewed in a spatial context. QA information tells if algorithm results were nominal, abnormal, cloud obscured, invalid, or if other defined conditions were encountered for a pixel. A single custom local attribute describing the bit flag settings is written with this SDS (Table 7). If all the input data and calculations in the algorithm were nominal for a pixel the QA bit is set to “nominal”. If data showed abnormal values, e.g. out of range values, the algorithm proceeds and outputs a value but flags it as “abnormal”. If the pixel is cloud obscured then the bit setting is “cloud”. If invalid data or calculations result in unacceptable values the bit setting is “invalid”. There was concern that views to the far left and right of nadir in a scan may have affected the identification of sea ice in the algorithm so bit 3 is set to identify observations acquired greater than 45 degrees from nadir.

Local Attributes

Predefined HDF local attributes for the QA SDS are listed in Table 3. A single custom local attribute is written that describes the meaning of the QA bit flags.

Table 7. Definition of the Custom Local Attribute

Attribute Name	Definition
Key:	“state of bits 0 and 1; 00=nominal, 01=abnormal, 10=cloud, 11=invalid; state of bit 3; 0=within45 deg scan angle, 1=beyond 45 deg scan angle; state of bit 4; 0=nominal band_6, 1=second sample band_6."

Ice Surface Temperature SDS

Estimated ice surface temperature (IST) by the algorithm described in the above **Algorithm Description** section is stored in this SDS. The IST is expressed in degrees Kelvin and is stored as calibrated data. To retrieve the IST the data must be descaled to degrees Kelvin using the calibration attributes, i.e.;

IST (K) = “scale_factor” * (calibrated data – “add_offset”).

The custom local attributes stored with the SDS are listed in Table 8. Coefficients used in the IST equation are given as local attributes. Those coefficients vary with temperature range and with hemisphere. The HDF predefined local attributes (Table 3) including “Calibration” are stored with this SDS.

The valid range for IST is 243.00 – 273.00 K. Other features such as land and clouds are coded with integer values ≤ 5000. Values ≤ 5000 are not valid IST values but represent the occurrence of land, clouds or other features or conditions in the swath.

Local Attributes

Archived with the "Ice Surface Temperature" SDS are local attributes that describe the data. HDF predefined local attributes (Table 3) describe characteristics of the data, and custom local attributes (Table 8) provide some information about the data. The HDF-predefined local attribute "Calibration" (Table 3) is used because the sea ice temperature data are stored in calibrated format.

Table 8. Local Attributes for the “Ice Surface Temperature” SDS.

Attribute Name	Definition	Sample Value
Key:	Key to meaning of data in the SDS	“50.0=cloud, 39.0=open ocean…”
Valid EV Obs Band 31 (%)	The percentage of valid observations from Level 1B in band 31 in the swath. (0.0-100.0)	100.0

Valid EV Obs Band 32 (%)	The percentage of valid observations from Level 1B in band 32 in the swath. (0.0-100.0)	100.0
Saturated EV Obs Band 31 (%)	The percentage of saturated observations from Level 1B in band 31 in the swath. (0.0-100.0)	0.287
Saturated EV Obs Band 32 (%)	The percentage of saturated observations from Level 1B in band 32 in the swath. (0.0-100.0)	0.779
Auto_Check_QA	For internal QA checks	“Acceptable”
IST coefficients, <240	Coefficients used in the IST calculation for the given temperature range.	-0.15, 0.99, 1.39, -0.41
IST coefficients, 240-260		-3.32, 1.01,1.21, 0.13
IST coefficients, >260		-5.02, 1.01, 1.51, 0.26

Ice Surface Temperature Pixel QA SDS

The quality status of the IST calculation for each pixel is stored in this SDS. The purpose of the QA SDS is to give the user information on algorithm results for each pixel that can be viewed in a spatial context. QA information tells if algorithm results were nominal, abnormal, cloud obscured, invalid, or if other defined conditions were encountered for a pixel. A single custom local attribute describing the bit flag settings is written with this SDS (Table 9). If all the input data and calculations in the algorithm were nominal for a pixel the QA bit is set to “nominal”. If data showed abnormal values, e.g. out of range values, the algorithm proceeds and outputs a value but flags it as “abnormal”. If the pixel is cloud obscured then the bit setting is “cloud”. If invalid data or calculations result in unacceptable values the bit setting is “invalid”.

Local Attributes

Table 9. Definition of the Custom Local Attribute.

Attribute Name	**Definition**
Key:	“state of bits 0 and 1; 00=nominal, 01=abnormal, 10=cloud, 11=invalid”

Sea Ice by IST SDS

Sea ice extent, as determined by a threshold of ice surface temperature (IST) is stored in this SDS. The IST threshold is 271.5 K; any pixel with an IST less than or equal to 271.5 K is identified as sea ice and any pixel with an IST greater than 271.5 K is identified as open ocean. That threshold IST was determined from early algorithm development work with the MODIS Airborne Simulator (MAS) and on data in the literature. That threshold IST for sea ice will probably change after validation studies are completed. This temperature mapping of sea ice extent is included to provide an easily displayed visual extent of sea ice by IST. A user may generate their own sea ice extent by IST using a different temperature criterion with the IST data.

Local Attributes

Table 10. Definition of the Custom Local Attribute.

Attribute Name	Definition
Key:	“200=sea_ice, 50=cloud, 39=open ocean, 37=inland water, 25=land, 11=night, 1=no decision, 0=missing”

Combined Sea Ice SDS

The agreement and/or disagreement between sea ice identified by reflectance characteristics or by estimated ice surface temperature (IST) are mapped in this SDS. Data shows pixels that were detected as sea ice in both the sea ice by reflectance SDS and sea ice by IST SDS, and where the two techniques differed in detection of sea ice. Presence of other features, e.g. land, should be consistent between those two SDS. This combined sea ice map is included to provide and easily displayed map of sea ice as determined by both the reflectance and IST data. A user may generate their own combination map using the reflectance and IST data with criteria of their own design.

Local Attributes

Table 11. Definition of the Custom Local Attribute.

Attribute Name	Definition
Key:	“237=seaice by both reflectance and IST, 170=seaice by reflectance only, 150=seaice by IST only, 50=cloud, 39=open ocean, 37=inland water, 25=land, 11=night, 1=no decision, 0=missing”

Global Attributes

There are eight global attributes: three ECS; *CoreMetadata.0, ArchiveMetadata.0,* and *StructMetadata.0;* and seven product unique attributes in the MOD29 data product. Contents of these global attributes were determined and written during generation of the product and are used in archiving and populating the EOSDIS database to support user services. The ECS global attributes are stored as very long character strings in parameter value language (PVL) format. The product unique global attributes carry some data quality related information. Descriptions of the global attributes are given here to assist the user in understanding them.

CoreMetadata.0 is the global attribute in which information compiled about the product during product generation is archived and was used to populate the EOSDIS database to support user services. The content of the three ECS global attributes with sample values and comment of definition are listed in Table 12, Table 13, and Table 14 (respectively.) The seven product unique attributes are given in Table 15. The user wanting detailed explanations of the global attributes and related information should query the HDF-EOS information and tools web sites listed in **Related Web Sites**.

Table 12. Listing of objects in the global attribute *CoreMetadata.0* in MOD29.

Object Name	**Sample Value**	**Comment**
LocalGranuleID	"MOD29.A2001193.1900.004.2002277041406.hdf"	
ProductionDateTime	"2002-10-04T04:14:22.000Z"	
DayNightFlag	"Day"	Can be Day, Both or Night
ReprocessingActual	"reprocessed"	
LocalVersionID	"SCF V2.2.3"	Version of algorithm delivered from the SCF.

ReprocessingPlanned	"further update is anticipated"	Expect that products will be reprocessed one or more times.
MeasuredParameterContainer		
ScienceQualityFlag	"Not investigated"	Set by sea ice investigator after post-production investigation
AutomaticQualityFLagExplanation	"No errors detected in processing"	Explanation of result of automated QA checks made during execution.
AutomaticQualityFlag	"Passed”	Result of automated checks during the run of the algorithm that screen for significant amounts of anomalous data.
SciencelQualityFlagExplanation	"See http://landdb1.nascom.nasa.gov/QA_WWW/ release.cgi for the Science QA status of this product.”	Explanation of Science Flag
QAPercentMissingData	0	0-100
QAPercentCloudCover	70	0-100

ParameterName	"Sea Ice by Reflectance", “Ice Surface Temperature”	Two parameters for which groups of QA metadata (next eight listed) are written for in two containers.
ShortName	"MOD29"	ESDT name of product
VersionID	1	ECS Version
PGEVersion	"2.4.2"	Version of production generation executable.
InputPointer	"MOD02HKM.A2000306.2125.002.2000329123327.hdf", …	Location of the three input files in the production system.
RangeBeginningDate	"2000-11-01"	Beginning and ending times of the first and last scan line in the swath.
RangeBeginningTime	"21:15:00.000000"	
RangeEndingDate	"2000-11-01"	
RangeEndingTime	"21:20:00.000000"	
ExclusionGRingFlag	"N"	Geographic bounds of swath coverage.
GringPointLatitude	[-172.918503, -96.373253, -126.193184, -166.482391]	
GringPointLongitude	[79.774231, 68.789673, 56.226749, 62.022076]	
GringPointSequenceNo	[1,2,3,4]	
OrbitNumber	4653	
EquatorCrossingLongitude	-163.416015	
EquatorCrossingDate	"2000-11-01"	

EquatorCrossingTime	"21:36:54.673540"	
OperationalQualityFlag	"Passed"	Set by production system.
OperationalQualityFlagExplanation	"Nominal Production"	Explanation of Operational Flag
AncillaryInputPointer	"MOD03.A2000306.2115.002.2000329112017.hdf"	Location of geolocation input product in production system.
AncillaryInputType	"Geolocation"	Type of ancillary data referenced by pointer.
AssociatedSensorShortName	"VNIR", “SWIR”, “TIR”	Three band regions used in the algorithm, three instances in the metadata.
AssociatedPlatformShortName	"Terra", "Terra", "Terra"	
AssociatedInstrumentShortName	"MODIS", "MODIS", "MODIS"	
Product Specific Attributes (PSA)		
QAPERCENTGOODQUALITY	90	Summary quality assurance statistic based on the thermal data. Range is from 0-100.
QAPERCENTOTHERQUALITY	0	
QAPERCENTNOTPRODUCEDCLOUD	10	
QAPERCENTNOTPRODUCEDOTHER	0	
GRANULENUMBER	257	Unique granule identifier
SEAICEPERCENT	42	Summary percentage of sea ice detected (0 – 100).

The ECS global attribute ArchiveMetadata.0 contains information relevant to production of the data product. It also contains an alternate bounding of geographic coverage of the swath. These data may be useful in determining what version of the algorithm was used to generate the product. Contents are described in Table 13.

Table 13. Listing of objects in the global attribute *ArchiveMetadata.0* in MOD29.

Object Name	**Typical Value**	**Comment**
EastBoundingCoordinate	-96.373256	Extent of swath coverage, in latitude and longitude.
WestBoundingCoordinate	-172.918502	
NorthBoundingCoordinate	80.036044	
SouthBoundingCoordinate	56.226751	
AlgorithmPackageAcceptanceDate	"2000-12-22"	Algorithm Descriptors
AlgorithmPackageMaturityCode	"PREL"	
AlgorithmPackageName	"MOD_PR29 Terra or Aqua full and coarse products"	
AlgorithmPackageVersion	"Version 2.3.3.0"	
InstrumentName	"Moderate-Resolution Imaging SpectroRadiometer"	
PlatformShortName	"Terra"	
ProcessingDateTime	"2001-01-22T16:41:07.000Z"	
LongName	"MODIS/Terra Sea Ice Extent 5-Min L2 Swath 1km"	
Processing Center	"MODAPS"	
SPSOParameters	"none"	
LocalInputGranuleID	["MOD-21KM...",...]	Names of the three input files.
DESCRRevison	“1.2”	Version of MCF file

The *StructMetadata.0* global attribute is used by the HDF-EOS toolkit to specify the mapping relationships between the geolocation data and the sea ice data (SDSs). Mapping relationships are unique in HDF-EOS and are stored in the product using HDF structures. Description of the mapping relationships is not given here.

Use of HDF-EOS toolkit, other EOSDIS supplied toolkits, or other software packages may be used to geolocate the data.

Table 14. Listing of objects in the global attribute *StructMetadata.0* in MOD29.

Object	**Definition**
DIMENSION_1	Coarse_swath_lines_5km
DIMENSION_2	Coarse_swath_pixels_5km
DIMENSION_3	Along_swath_lines_1km
DIMENSION_4	Cross_swath_pixels_1km
DIMENSIONMAP_1	GeoDimension=Coarse_swath_pixels_5km DataDimension=Cross_swath_pixels_1km Offset=2 Increment=5
DIMENSIONMAP_2	GeoDimension=Coarse_swath_lines_5km DataDimension=Along_swath_lines_1km Offset=2 Increment=5
GEOFIELD_1	GeoFieldName=Latitude
GEOFIELD_2	GeoFieldName=Longitude
DATAFIELD_1	DataFieldName=Sea Ice by Reflectance
DATAFIELD_2	DataFieldName=Sea Ice by Reflectance PixelQA
DATAFIELD_3	DataFieldName=Ice Surface Temperature
DATAFIELD_4	DataFieldName=Ice Surface Temperature PixelQA
DATAFIELD_5	DataFieldName=Sea Ice by IST
DATAFIELD_6	DataFieldName=Combined Sea Ice

Table 15. MOD29 product specific global attributes.

Attribute Name	**Sample Value**	**Comment**
L1BCalibrationQuality	“marginal”	
L1BMissionPhase	“A&E”	

L1BNadirPointing	“Yes”	
L1BVersionID	"2001-07-12"	
L1BAutoQA_EV_1KM_RefsB	“Suspect”	Result of generalized quality analysis of L1B data
SCF Algorithm Version	“$Id: MOD_PR29_AA…”	SCF versioning tracking information.

MOD29PG Sea Ice Product

The level-2-gridded (L2G) product is the result of mapping all the MOD29 swaths acquired during day or night to grid cells of a map projection. Projection used for the sea ice products is the Lambert Azimuthal Equal-Area (polar grids) projection, EASE-Grid. The MOD29PG product is a necessary intermediate product used as input to the daily sea ice product MOD29P1. Separate products are generated for day or night. MOD29PGD and MOD29P1D are the day products and contain data acquired in day mode of the MODIS sensor. MOD29PGN and MOD29P1N are the night products and contain data acquired in night mode of the MODIS sensor. The MOD29PG* products are not archived at NSIDC and are not available for order through ECS. Only brief summary descriptions are given for this product because it is not an orderable product.

The Lambert Azimuthal Equal-Area projection is divided into Northern and Southern polar grids. The polar grids are based on the Lambert Azimuthal Equal Area map projection centered on each pole. The grids are compatible with the NSIDC EASE-Grid. Each grid contains 313 tiles with each tile covering approximately 10 x 10 degrees. Some references relevant to the Lambert Azimuthal Equal-Area projection can be found in the **Related Documents** section of this guide.

Algorithm Description

The MODL2G algorithm was created as a generic gridding algorithm for many of the MODIS data products in the land discipline group, and was customized to each MODIS data product as necessary. See Wolfe et al. (1998) and Yang and Wolfe (2001) for a description of the gridding technique and product contents. The L2G algorithm maps pixels from the MOD29 SDSs into cells of the map grid. No calculations or analysis of sea ice is done at L2G.

Quality Assurance

Aside from QA indicating the status of an algorithm run and status of the gridding results, no automated QA analysis of the sea ice data is done in the algorithm.

Scientific Data Sets

Sea ice data from MOD29 along with data on from which MOD29 granule the observations came from are stored in the SDSs of the MOD29PG product. Data are stored in a compact format to reduce storage volume.

Local Attributes

The predefined HDF local attributes (Table 3) and one custom local attribute (Nadir_resolution) exist for the SDSs in the L2G product. No summary statistics are generated.

Global Attributes

ECS global attributes of *CoreMetadata.0, ArchiveMetadata.0* and *StructMetadata.0* exist and have basically the same content as the MOD29 product, though there is some variation, notably information on the polar grid.

MOD29P1D Day Daily Sea Ice Product

The daytime daily level-3 sea ice product is the result of selecting an observation from the multiple observations mapped to a cell of the MOD29G product as the observation of the day. The daily sea ice product is a tile of data gridded in the Lambert Azimuthal Equal Area map projection. Spatial resolution is approximately 1 km. Tiles are approximately 1200 x 1200 km in area. Six SDS along with local and global attributes compose the data product file.

Algorithm Description

From the many observations acquired during a day from multiple swath coverage of a location a single observation is selected as the observation of the day. A scoring algorithm is used to select the most favorable observation of the day based on solar elevation, observation coverage in a grid cell and distance from nadir. The objective of the algorithm is to select observations that were acquired near local noontime that had a large amount of coverage in a grid cell and that were near nadir. A weighting is given to these parameters in the algorithm. The form of the scoring algorithm is,

Score = (a * solar elevation) + (b * observation coverage) + (c * distance from nadir)

These data are read from the L2G products of sea ice (MOD29PG), geoangles (MODMGPG) and pointer

(MODPTPG). All observations for a day are scored and the one with the highest score is selected as the observation for the day. This algorithm is applied to daytime (reflectance) data. In day mode MODIS collects both visible and thermal data. The scoring algorithm uses the visible data to determine the observation of the day used for both the reflectance and thermal data. The thermal data observation corresponding to the visible observation is the IST observation of the day. For night (thermal) only tiles this scoring algorithm is used but without the solar elevation data. At night the observation with most coverage in a grid cell and closest to nadir is selected.

Quality Assurance

Automated QA is applied to check that the MOD29PG input values are valid, one of the values in Table 5 for visible data or a valid temperature. Valid values are flagged as acceptable (nominal) and invalid values are flagged as abnormal in the QA SDSs according to the quality of the input data.

Scientific Data Sets

Sea Ice By Reflectance SDS

Extent of sea ice as determined by reflectance characteristics is mapped in this SDS. The observation stored in the array is the one selected by the daily sea ice scoring algorithm (above) from all daylight observations for a day.

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDSs. Custom local attributes (Table 16) are used to provide summary information of sea ice and other features in the tile.

Table 16. Custom Local Attributes for the " Sea_Ice_by_Reflectance" SDS

Attribute Name	Definition	Sample Value
missing_value	Coded integer used to indicate missing data	0
Sea Ice_pct (%)	Areal coverage of sea ice. (0-100)	68
Ocean_pct (%)	Percentage of ocean in the tile. (0-100)	57
Cloud_area_pct (%)	Percentage of cloud in the tile. (0-100)	75

Land_area_pct (%)	Percentage of land in the tile. (0-100)	43
Key	Key to interpretation of coded integers.	"254=non-production mask, 200=sea ice, 50=cloud_obscured, 39=ocean, 37=inland_water, 25=land, 11=night, 1=no_decision, 0=missing_data"

Sea Ice by Reflectance Spatial QA SDS

Information on the quality of the selected observations is stored in this data array. Spatial quality assurance data are stored as bit flags in a byte. Bit settings are described in the following section.

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDSs. Custom local attributes (Table 17) are used to provide summary information of sea ice and other features in the data.

Table 17. Custom Local Attributes for the " Sea_Ice_by_Reflectance_Spatial_QA" SDS

Attribute Name	**Definition**	**Sample Value**
Nominal_results (%)	Percentage of nominal data in the tile.	14
Abnormal_results(%)	Percentage of abnormal data in the tile.	1
Invalid_input (%)	Percentage of invalid data in the tile.	85
Cloud_obscured (%)	Percentage of cloud in the tile.	10
Outside_relative_azimuth(%)	Percentage of land in the tile. (0-100)	0
Key	Key to interpretation of bit flags.	“state of bits 0 and 1; 00=nominal, 01=abnormal, 10=cloud, 11=invalid; state of bit 2: 0=within_azimuth_limit, 1=beyond_azimuth_limit, state of bit 3: 0=over_observation_coverage_min, 1=under_observation_coverage_min”

Ice Surface Temperature SDS

The algorithm selected estimated IST observation for the day is stored in this SDS. The data are stored in HDF calibrated form so must be converted using the calibration data in the local attributes.

IST (K) = “scale_factor” * (calibrated data – “add_offset”).

Estimated IST is expressed in degrees Kelvin.

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDSs. The predefine attribute “Calibration” is used with this SDS. Custom local attributes (Table 18) are used to provide information on features in the data.

Table 18. Custom Local Attributes for the " Ice_Surface_Temperature " SDS.

Attribute Name	Definition	Sample Value
Key	Key to interpretation of coded integers.	"50.0=cloud, 37.0=inland water, 25.0=land,7.0=tile fill, 5.0=non-production mask, 1.0=no_decision. 0.0=missing data"

Ice Surface Temperature Spatial QA SDS

Information on the quality of the selected observations is stored in this data array. Spatial quality assurance data are stored as bit flags in a byte. Bit settings are described in the following section.

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDSs. Custom local attributes (Table 19) are used to provide information on data in the tile. The first two QA bits are interpreted the same as those for the sea ice by reflectance SDS. Other QA bit settings are to be determined in a future revision.

Table 19. Custom Local Attributes for the " Ice_ Surface_Temperature_Spatial_QA" SDS.

Attribute Name	Definition	Sample Value
Nominal_results (%)	Percentage of nominal data in the tile.	89

Abnormal_results(%)	Percentage of abnormal data in the tile.	1
Invalid_input (%)	Percentage of invalid data in the tile.	0
Cloud_obscured (%)	Percentage of cloud in the tile.	10

Sea Ice by Ice Surface Temperature SDS

Extent of sea ice is determined by a sea ice temperature threshold applied to the daily IST data. In the current version, a temperature of 271.5 K is used as the threshold for sea ice. A user may generate their own sea ice extent by IST using a different temperature criterion with the daily IST data.

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDSs. Custom local attributes (Table 20) are used to provide summary information of sea ice and other features in the tile.

Table 20. Custom Local Attributes for the " Sea_Ice_by_Ice_Surface_Temperature" SDS.

Attribute Name	**Definition**	**Sample Value**
missing_value	Coded integer used to indicate missing data.	0
Cloud_cover (%)	Percentage of cloud obscured ocean. (0-100)	91
Ocean_percentage (%)	Percentage of ocean in the tile (0-100)	93
Sea_ice_percentage (%)	Areal coverage of sea ice. (0-100)	0
No_decision (%)	Percentage of no decision results (0-100)	1
Invalid_input_data (%)	Percentage of invalid data in the tile (0-100)	0

Combined Sea Ice SDS

The agreement and/or disagreement between sea ice identified by reflectance characteristics or by estimated ice surface temperature (IST) are mapped in this SDS. Data shows pixels that were detected as sea ice in both the sea ice by reflectance SDS and sea ice by IST SDS, and where the two techniques differed in detection of sea ice. The observations stored in the array are the ones selected by the daily sea ice algorithm from all observations for a day.

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDS. Custom local attributes (Table 21) are used to provide information on data in the tile.

Table 21. Definition of the Custom Local Attribute.

Attribute Name	Definition
Key	“237=seaice by both reflectance and IST, 170=seaice by reflectance only, 150=seaice by IST only, 50=cloud, 39=open ocean, 37=inland water, 25=land, 11=night, 1=no decision, 0=missing”

Global Attributes

Three ECS global attributes and two product-specific global attributes are stored as metadata. The ECS global attributes, *CoreMetadata.0*, *ArchiveMetadata.0* and *StructMetadata.0* are stored as very long character strings in PVL format. Descriptions of the objects in these ECS global attributes and the product-specific global attributes are listed in Tables 22 – 24.

CoreMetadata.0 contains information about the product during production and is used to populate the EOSDIS database for user support. It also contains summarized QA information. A listing of objects along with sample values is given in Table 22.

Table 22. *CoreMetadata.0* of the MOD29P1D data product.

Object Name	Sample Value	Comment
ShortName	"MOD29P1D"	ESDT name of product
VersionID	1	ESC Version
ReprocessingActual	"processed once"	Number of times processed.
ReprocessingPlanned	"further update is anticipated"	Expect that products will be reprocessed one or more times.

LocalGranuleID	"MOD29P1D.A2000360. h08v05.002.20010577071942.hdf"	Name of the granule.
DayNightFlag	"Day"	
ProductionDateTime	"2001-02-26T07:19:52.000Z"	Time granule was produced.
LocalVersionID	"SCF V2.1.1"	Version of algorithm delivered from the SCF.
PGEVersion	"2.2.5"	Version of PGE in MODAPS.
InputPointer	"MOD29PGD.A2000360.h08v05…"	Location of input files in the production system.
RangeBeginningDate	"2000-12-25"	Beginning and ending times of the first and last scan line in the swath
RangeBeginningTime	"20:40:00.000000 "	
RangeEndingDate	"2000-12-26"	
RangeEndingTime	"00:00:00.000000 "	
ExclusionGRingFlag	"N"	Geographic bounds of swath coverage.
GringPointLatitude	[48.416946, 50.389365, 59.316235, 56.887169]	
GringPointLongitude	[-161.565051, -173.659808, -171.869898, -156.801409]	
GringPointSequenceNo	[1, 2, 3, 4]	
OrbitNumber	5439	Orbit Identifiers from each of the MOD29 input swaths.
EquatorCrossing Longitude	-154.222714	
EquatorCrossingDate	"2000-12-25"	
EquatorCrossingTime	"20:59:14.690954"	

ParameterName	"Sea_Ice_by_Reflectance" "Ice_Surface_Temperature"	Two parameters for which QA statistics are given. Two containers for the following four QA statistics used.
AutomaticQualityFlag	"Passed"	Result of automated checks done on the data during a run of algorithm. Useful for screening for anomalous data.
AutomaticQualityFlag Explanation	"No errors detected in processing"	Explanation of result of automated QA checks made during execution.
QAPercentMissingData	1	0-100
QAPercentCloudCover	5	0-100
AssociatedPlatform ShortName	"Terra"	Given for each group of detectors used in the algorithm; “VNIR”, “SWIR”, “TIR”
AssociatedInstrument ShortName	"MODIS"	
AssociatedSensor ShortName	"VIS"	
****Product Specific Attributes (PSA)****		
QAPERCENTGOODQUALITY	95	Summary quality assurance statistic for data product (0 – 100).
QAPERCENTOTHERQUALITY	2	
QAPERCENTNOTPRODUCEDCLOUD	6	
QAPERCENTNOTPRODUCEDOTHER	3	
HORIZONTALTILENUMBER	"08"	
VERTICALTILENUMBER	"05"	

TileID	"31008005"	
SEAICEPERCENT	68	Summary percentage of sea ice (0 - 100).

The ECS global attribute *ArchiveMetadata.0* contains information relevant to the input data, an alternate geographic coverage bounds, and information relevant to version of the algorithm and product. A listing of objects along with sample values is given in Table 23.

Table 23. *ArchiveMetadata.0* of the MOD29P1D data product.

Object Name	**Sample Value**	**Comment**
CharacteristicBinAngularSize	71.725054	
CharacteristicBinSize	1002.701000	
GEOAnyAbnormal	"False"	
GEOEstMaxRMSError	200.000000	
DataColumns	951	
DataRows	951	
GlobalGridColumns	18069	
GlobalGridRows	18069	
Numberofoverlapgranules	3	Number of staged granules that were mapped into this tile.
Numberofinputgranules	6	Total number of MOD29input granules staged.
Coveragecalculationmethod	“area”	
AlgorithmPackageAcceptanceDate	"1999-10-28"	Algorithm Descriptors
AlgorithmPackageMaturityCode	"pre-launch"	
AlgorithmPackageName	"MOD29AV2"	
AlgorithmPackageVersion	"Version 2.2.1"	

InstrumentName	"Moderate-Resolution Imaging SpectroRadiometer"	
PlatformShortName	"Terra"	
ProcessingDateTime	"2001-02-26T07:19:42.000Z"	
LongName	"MODIS/Terra Sea Ice Extent Daily L3 Global 1km EASE-Grid Day"	
ProcessingCenter	"MODAPS"	
SPSOParameters	"none"	
LocalInputGranuleID	"MOD29PGD…",…	
EastBoundingCoordinate	-156.801409	Extent of coverage of swath.
WestBoundingCoordinate	-173.659808	
NorthBoundingCoordinate	59.316235	
SouthBoundingCoordinate	48.416946	

The StructMetadata.0 global attribute is used by the HDF-EOS toolkit to create the mapping relationships between the defined grid and data (SDSs). Parameters of the projection are stored in StructMetadata.0.

Table 24. *StructMetadata.0* of the MOD29P1D data product.

Object Name	**Sample Value**
GRIDNAME	"MOD_Grid_Seaice_1km"
PROJECTION	GCTP_LAMAZ
DATAFIELD_1	"Sea_Ice_by_Reflectance"
DATAFIELD_2	"Sea_Ice_by_Reflectance_Spatial_QA"
DATAFIELD_3	“Ice_Surface_Temperature”
DATAFIELD_4	“Ice_Surface_Temperature_Spatial_QA”
DATAFIELD_5	“Sea_Ice_by_Ice_Surface_Temperature”
DATAFIELD_6	“Combined_Sea_Ice”

Other global attributes in the product are listed in Table 25.

Table 25. MOD29P1D product specific global attributes.

Attribute Name	Sample Value	Comment
SCF Algorithm Version	$id: MOD_PR29A1…	Version of code used.
MOD29InputGranuleNames	[“MOD29.A200036...”,...]	Listing of input files used to make the data product.

MOD29P1N Night Daily Sea Ice Product

This product contains only estimated ice surface temperature (IST) data processed from MODIS thermal data acquired during night mode operation of the sensor. Three SDSs are stored in the product. The nighttime sea ice product is a tile of data gridded in the Lambert Azimuthal Equal Area map projection. Spatial resolution is approximately 1 km. Tiles are approximately 1200 x 1200 km in area.

Algorithm Description

The objective of the algorithm is to select observations that were acquired nearest nadir and with the largest amount of coverage in a grid cell. A weighting is given to these parameters in the algorithm. The form of the scoring algorithm is,

Score = (b * observation coverage) + (c * distance from nadir)

These data are read from the L2G products of sea ice (MOD29PG) and pointer (MODPTPG). All observations for a day are scored and the one with the highest score is selected as the observation for the day.

Quality Assurance

Automated QA is applied to check that the MOD29PG input values are valid temperature values. Valid values are flagged in the QA SDS relevant to quality of the input data.

Scientific Data Sets

Ice Surface Temperature SDS

The observation selected by the algorithm as the observation of the night is stored in this SDS. Data are stored as scaled integers and must be de-scaled to degrees Kelvin using the “Calibration” local attribute.

IST (K) = “scale_factor” * (calibrated data – “add_offset”).

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDS, including the “Calibration” attribute. Custom local attributes (Table 26) are used to provide information on data in the tile.

Table 26. Definition of the Custom Local Attribute.

Attribute Name	Definition
Key	“50.0=cloud,37.0=inlandwater,25.0=land,7.0=tile fill,5.0=non-production mask,3.0=scan angle exceeded,1.0=no decision,0.0=missing data”

Ice Surface Temperature Spatial QA SDS

Information on the quality of the selected observations is stored in this data array. Spatial quality assurance data are stored as bit flags in a byte. Bit settings are described in the following section.

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDS. Custom local attributes (Table 27) are used to provide summary information on features in the data. The preliminary version of the product did not have a “Key” attribute written to it. Meaning of the QA bit flags is; state of bits 0 and 1; 00=nominal, 01=abnormal, 10=cloud, 11=invalid. No other bits were set in the preliminary data product.

Table 27. Custom Local Attributes for the "Ice_ Surface_Temperature_Spatial_QA" SDS

Attribute Name	Definition	Sample Value
Nominal_results (%)	Percentage of nominal data in the tile	89
Abnormal_results(%)	Percentage of abnormal data in the tile	1
Invalid_input (%)	Percentage of invalid data in the tile.	0
Cloud_obscured (%)	Percentage of cloud in the tile.	10

Sea Ice by Ice Surface Temperature SDS

The observation selected by the algorithm as the observation of the night is stored in this SDS.

Local Attributes

HDF predefined local attributes (Table 3) describe the structure and characteristics of the SDS. Custom local attributes (Table 28) are used to provide summary information of sea ice and other features in the tile. A “Key” to interpretation attribute was not written in the preliminary data product. Integer values have the following meanings; 200 = sea ice, 50 = cloud obscured, 39 = ocean (open water), 37 = inland water, 25 = land, 7 = filled area of a tile, 5 = non-production mask, 1 = no decision, 0 = missing data.

Table 28. Custom Local Attributes for the " Sea_Ice_by_Ice_Surface_Temperature" SDS

Attribute Name	Definintion	Sample Value
missing_value	Coded integer used to indicate missing data	0
Cloud_cover (%)	Percentage of cloud obscured ocean. (0-100)	91
Ocean_percentage (%)	Percentage of ocean in the tile (0-100)	93
Sea_ice_percentage (%)	Areal coverage of sea ice. (0-100)	0
No_decision (%)	Percentage of no decision results (0-100)	1
Invalid_input_data (%)	Percentage of invalid data in the tile (0-100)	0
Missing_data (%)	Percentage of missing data in the tile (0-100)	0

Global Attributes

The global attributes in MOD29P1N are the same as in MOD29P1D. Refer to Tables 23-25 for a listing of the global attributes. Content of some of the attributes is changed germane to the night product.

Related Web Sites

EOS

1. **Terra Website**: http://terra.nasa.gov

2. **ECS**: http://ecsinfo.gsfc.nasa.gov

3. **National Snow and Ice Data Center**: http://nsidc.org

MODIS

4. **MODIS Snow/Ice Global Mapping Project**: http://snowmelt.gsfc.nasa.gov/MODIS_Snow/modis.html

5. **MODIS Project**: http://modis.gsfc.nasa.gov

6. **MODIS Land Discipline**: http://modis-land.gsfc.nasa.gov

7. **Cloud Mask (MOD35)**: http://cimss.ssec.wisc.edu/modis1/pdf/CMUSERSGUIDE.PDF

HDF-EOS Information and Tools

8. **EOSDIS**: http://spsosun.gsfc.nasa.gov/ESDIShome.html

9. **HDF**: http://hdf.ncsa.uiuc.edu

10. **HDF-EOS**: http://hdfeos.gsfc.nasa.gov
    Note: Samples of HDF-EOS files can be obtained from this site.

11. **ECS Data Handling System**: http://edhs1.gsfc.nasa.gov/

12. **Viewing HDF and HDF-EOS files**: http://hdfeos.gsfc.nasa.gov/hdfeos/viewingHDFEOS.html

Earth Science

13. **GSFC Code 900 Earth Sciences Portal**: http://earthsciencesportal.gsfc.nasa.gov

Related Documents

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Stackpole, John D., July 1, 1994: "The WMO Format for the Storage of Weather Product Information and the Exchange of Weather Product Messages in Gridded Binary Form," Office Note 388, GRIB Edition 1, U.S. Dept. of Commerce, NOAA, National Weather Service National Meteorological Center, Automation Division, Section 1, pp. 9-12.

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Rossow, William B., and Leonid Garder, Aug. 1984: "Selection of a Map Grid for Data Analysis and Archival," *American Meteorological Society Notes*, pp. 1253-1257, Aug. 1984.