MODIS Sea Ice Products User Guide to Collection 5

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Introduction

The MODIS Sea Ice Products User Guide to Collection 5 of the MODIS products has been expanded with information regarding characteristics and quality of sea ice products at each level. A user should find information on characteristics and quality that affect interpretation and use of the products.   In content this guide includes information and explanations that should enhance a user's understanding of the products. Each product section of the guide has been expanded to include descriptions and explanations of characteristics and quality of the product and the online guide has links (or future links) to imagery and graphics exemplifying those characteristics.

The MODIS sea ice product suite is created as a sequence of products beginning with a swath (scene) and progressing, through spatial and temporal transformations, to a daily global sea ice product. Each sea ice product in the sequence after the swath product assimilates accuracy and error from the preceding product. A user must understand how the accuracy and quality of a product is affected by the previous level(s) of input products. Distribution statistics from the DAAC reveal that the swath and daily tiled sea ice products are the most frequently queried and distributed of the sea ice products. Understanding the assimilation of accuracy and error between levels and through higher levels is necessary to make optimal use of the products. Description of assimilated error and how it affects the accuracy of the product is included in each product section. A user may want to study the preceding product(s) description to enhance their understanding of the product accuracy at a particular level.

MODIS Terra and MODIS Aqua versions of the sea ice products are generated. This user guide applies to products generated from both sensors but is written based primarily on the Terra products. Bias to Terra is because the sea ice detection algorithm is based on use of visible and near infrared data at 1.6 μm. A primary key to sea ice detection is the characteristic of snow covered sea ice to have high visible reflectance and low reflectance in the near infrared, MODIS band 6. MODIS band 6 (1.6 μm) on Terra is fully functional however, MODIS band 6 on Aqua is only about 30% functional; 70% of the band 6 detectors non-functional. That situation on the MODIS Aqua caused a switch to band 7 (2.1 μm) for sea ice mapping in the swath level algorithm. The bias to Terra is also because of the greater understanding of the MODIS Terra sensor, pre-launch algorithm development, longer data record of Terra and greater amount of testing the Terra algorithms in preparation for Collection 5 processing.   The ice surface temperature (IST) algorithm is the same for both Terra and Aqua because the thermal bands are essentially the same on both MODIS sensors. Discussion of reasons for the different bands and the effect on snow covered sea ice mapping are beyond the scope of this user guide but are discussed in the MODIS sea ice ATBD (modis-snow-ice.gsfc.nasa.gov/). Despite the different band usage, the sea ice algorithms are very similar and the quality of sea ice mapping is very similar though subtle differences exist between the products. The higher level (Level-3) product algorithms are the

same for Terra and Aqua. Similarities and differences between Terra and Aqua are presented in the appropriate product section.

The guide is organized into overview sections and data product sections. Overview sections cover commonalities in the data products or describe external sources of information relevant to the products. Data product sections are composed of a succinct algorithm description, data content description and explanations of error and characteristics that should enhance a user's understanding of each sea ice product.

New in Collection 5

Collection 5 reprocessing began in July 2006 starting with the first day of MODIS science data acquisition, 24 February 2000. Minor changes were made in the algorithms and products for Collection 5. Those changes have not affected the quality of the sea ice data products; the quality is consistent between Collection 4 (C4) and Collection 5 (C5). Notable changes are:

The level 2 MOD29 products are compressed using the NCSA hrepack algorithm. Users may or may not encounter difficulty in accessing these data files because of that compression and software tools used. For more information on HDF and tools to read and convert HDF-EOS check the related web sites section. The level 3 and higher MOD29 products were internally compressed using HDF routines; that compression should be transparent to users. Compression greatly reduced file size, resulting in less storage demand and quicker transfer/downloads of data.

A naming convention for the SDS names was adopted and applied across all the products. Some of the SDS names have been changed in C5.

A local attribute named "Key" is included with every SDS. Key describes the meaning of values in the SDS. Values are ordered from lowest to highest in the key.

A thematic quality assessment (QA) approach was taken. Spatial quality assessment data is stored as integer values in C5 as compared to the bit encoded scheme used in C4. Reason for the change was to allow the QA data to be more easily accessible by a user.

MOD29

The SDSs of *Sea Ice by IST* and *Combined Sea Ice* were deleted from this product for C5. The user is given the flexibility to generate these maps based on their own requirements using the IST and sea ice by reflectance SDSs in the product.

MOD29P1D

The SDSs of *Sea_Ice_by_Ice_Surface_Temperature* and *Combined_Sea_Ice* were deleted from this product for C5. The user is given the flexibility to generate these maps based on their own requirements using the IST and sea ice by reflectance SDSs in the product.

MOD29P1N

The SDS of *Sea_Ice_by_Ice_Surface_Temperature* was deleted from this product for C5. The user is given the flexibility to generate this map based on their own requirements using the IST SDS in the product.

MOD29E1D
    No changes were made for C5.

Sequence of Sea Ice Products
    Sea ice data products are produced as a series of four products. The sequence begins as a swath (scene) at a nominal pixel spatial resolution of 1 km and nominal swath coverage of 2330 km (cross track) by 2030 km (along track, five minutes of MODIS scans) in areal coverage. A summarized listing of the sequence of products is given in Table 1. Products in the Earth Observation System Data Information System (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. The L2G products are not archived. 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 an intermediate, not archived, 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. The projection is divided into 361 tiles covering each hemisphere. Information on how the pixels were mapped to the cells is stored in a pointer product associated with the L2G product. The third product, MOD29P1 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.   The fourth product, MOD29E1, is a daily global map of ice extent and IST at 4 km resolution generated from compositing of the MOD29P1 product.
    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;

MOD29pto
Where,
p – is the projection
P – polar, EASE-Grid
E --EASE-Grid polar projection, hemispheres

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 polar
MOD29PGN	L2G	1200 by 1200	1 km	day of multiple coincident swaths	EASE-GRID polar
MOD29P1D	L3	1200 by 1200	1 km	day	EASE-GRID polar
MOD29P1N	L3	1200 by 1200	1 km	day	EASE-GRID polar
MOD29E1	L3	4501 by x 4501 northern and southern hemispheres	4 km	day	EASE-GRID polar, northern and southern hemispheres

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 should consult the 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 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 assessment (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 metadata file should be examined to determine if post production QA has been applied to the granule. (The Quality Assessment 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.

MOD29

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, ice surface temperature (IST) and quality assessment (QA) SDSs, also latitude and longitude SDSs, all with local attributes and global attributes. The sea ice algorithm identifies sea ice-covered oceans by reflectance characteristics; it also estimates ice surface temperature (IST) by the split-window technique. For complete global 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.

An example of the MOD29 sea ice extent and IST maps from 3 April 2003 2240 UTC are exhibited in Figure 1. The sea ice algorithm and data product contents are described in the following sections.

Algorithm Description

A sketch of the sea ice algorithm is described here for the purpose of aiding the user in understanding and interpreting the data product. The snow algorithm is described in detail in the Algorithm Theoretical Basis Document (ATBD).

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). 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 in the sea ice algorithm for both day and night conditions 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). In Collection 5 the land/water mask made by the Boston University (BU) team based on EOS data is used as the land/water mask in MOD03. During Collection 4 the BU land/water mask replaced the EOS land/water mask that had been used. (More information is given on the land/water mask in QA sections below.)

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 are 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 but, the result may affect the setting of the quality assessment data to indicate an unusual condition.

Ice surface temperature (IST) is calculated 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. 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. Coefficients are given in Table 3. (The coefficients are also given as local attributes in the Aqua product but have been omitted from the Terra product in C5.)

IST = IST = $a + b$T11 + 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.

Table 3 Coefficients used in the calculation of IST. Same coefficients are used for Terra and Aqua MODIS sensors.

Northern Hemisphere	*a*	*b*	*c*	*d*
< 240 K	-1.5711228087	1.0054774067	1.8532794923	-0.7905176303
240 – 260 K	-2.3726968515	1.0086040702	1.6948238801	-0.2052523236
> 260 K	-4.2953046345	1.0150179031	1.9495254583	0.1971325790
Southern Hemisphere	*a*	*b*	*c*	*d*
< 240 K	-0.1594802497	0.9999256454	1.3903881106	-0.4135749071
240 – 260 K	-3.3294560023	1.0129459037	1.2145725772	0.1310171301
> 260 K	-5.2073604160	1.0194285947	1.5102495616	0.2603553496

The MODIS L1B data is screened for missing data and for unusable data. Unusable data results from the processing at L1B when the sensor radiance data fails to meet acceptable criteria. MODIS data may be unusable for several reasons. Specifics of L1B processing and criteria can be found at the MODIS Calibration Support Team (MCST) web page and in supporting documentation. 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 decision for that pixel, except for some expected anomalous conditions where a value indicating the source of the anomaly is written.

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

Scientific Data Sets
Sea_Ice_by_Reflectance

The sea ice map produced based on the sea ice by reflectance in the algorithm is stored as coded integers in the *Sea_Ice_by_Reflectance* SDS. The sea ice algorithm identifies pixels as sea ice, ocean, land, inland water, cloud or other condition. A color-coded image of a sea ice extent map is shown in Figure 1b, from 2 April 2000 covering the Bering Sea and part of Arctic Ocean alongside a false-color reflectance image of the swath Fig. 1a. A polar projection map of that sea ice extent map is show in Figure 2. HDF predefined and custom local attributes are also stored. The HDF predefined attributes may be used by some software packages. The custom local attributes are specific to the data in the SDS. Local attributes are listed in Table 4.

Table 4. Local attributes for the *Sea_Ice_by_Reflectance* SDS.

Attribute Name	Definition	Value
long_name*	Long Name of the SDS	Sea ice by reflective characteristics
units*	SI units of the data, if any	none
format*	How the data should be viewed, Fortran format notation	I3
coordsys*	Coordinate system to use for the data	cartesian
valid_range*	Max and min values within a selected data range	0-254
_FillValue*	Data used to fill gaps in the swath	255
Key	Key to meaning of data in the SDS	0=missing data, 1=no decision, 11=night, 25=land, 37=inland water, 39=ocean, 50=cloud, 100=lake ice, 200=sea ice, 254=detector saturated, 255=fill
Nadir_data_resolution	Nominal spatial resolution of the pixels at nadir	1 km
Valid EV Obs Band 2 (%)	The percentage of valid observations from Level 1B in Band 2 in the swath.	0.0 - 100.0
Valid EV Obs Band 4 (%)	The percentage of valid observations from Level 1B in Band 4 in the swath.	0.0 - 100.0
Valid EV Obs Band 6 (%)	The percentage of valid observations from Level 1B in Band 6 in the swath.	0.0 - 100.0
Saturated EV Obs Band 1 (%)	The percentage of saturated observations from Level 1B in Band 1 in the swath.	0.0 - 100.0
Saturated EV Obs Band 2 (%)	The percentage of Saturated observations from Level 1B in Band 2 in the swath.	0.0 - 100.0
Saturated EV Obs Band 4 (%)	The percentage of saturated observations from Level 1B in Band 4 in the swath.	0.0 - 100.0
Saturated EV Obs Band 6 (%)	The percentage of saturated observations from Level 1B in Band 6 in the swath.	0.0 - 100.0

* HDF predefined attribute names.

Ice_Surface_Temperature

Ice surface temperature (IST) calculated by the split-window technique (see 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 valid range for IST is 210.00 – 313.00 K or 21000 – 31300 in calibrated form. 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. The local attributes stored with the SDS are listed in Table 5. Coefficients used in the IST equation are given in Table 3. The HDF-predefined local attribute Calibration (a structure) containing the scale and offset factors (Table 5) is used because the IST data are stored in calibrated format.

Table 5. Local Attributes for the Ice_Surface_Temperature SDS.

Attribute Name	Definition	Value
long_name*	Long Name of the SDS	Ice Surface Temperature by split-window method
units*	SI units of the data, if any	Degree_Kelvin
format*	How the data should be viewed, Fortran format notation	F3.2
coordsys*	Coordinate system to use for the data	cartesian
valid_range*	Max and min values within a selected data range	21000, 31300
_FillValue*	Data used to fill gaps in the swath	65535
scale_factor*	Scale factor of calibrated data	0.010000
scale_factor_err*	Scale factor error of calibrated data	0.000000
add_offset*	Offset of calibrated data	0.000000
add_offset_err*	Offset error of calibrated data	0.000000
calibrated_nt*	Data type of calibrated data	5
Key	Key to meaning of data in the SDS	0.0=missing data, 1.0=no decision, 11.0=night, 25.0=land, 37.0=inland water, 39.0=ocean, 50.0=cloud, 243.0-273.0 expected IST range, 655.35=fill
Valid EV Obs Band 31 (%)	The percentage of valid observations from Level 1B in band 31 in the swath.	0.0-100.0

Valid EV Obs Band 32 (%)	The percentage of valid observations from Level 1B in band 32 in the swath.	0.0-100.0
Saturated EV Obs Band 31 (%)	The percentage of saturated observations from Level 1B in band 31 in the swath.	0.0-100.0
Saturated EV Obs Band 32 (%)	The percentage of saturated observations from Level 1B in band 32 in the swath.	0.0-100.0

* HDF predefined attribute names.

Latitude and *Longitude*

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_Reflectance* SDS; the algorithm then increments by 10 in the cross-track or along-track direction to map geolocation data to the SDS.

Table 6. Local attributes with *Latitude* SDS.

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Coarse 5 km resolution latitude
units*	SI units of the data, if any	degrees
valid_range*	Max and min values within a selected data range	-90.00, 90.00
_FillValue*	Data used to fill gaps in the swath	-999.000
source	Source of data	MOD03 geolocation product; data read from center pixel in 5 km box

* HDF predefined attribute names.

Table 7. Local attributes with *Longitude* SDS.

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Coarse 5 km

		resolution longitude
units*	SI units of the data, if any	degrees
valid_range*	Max and min values within a selected data range	-180.00, 180.00
_FillValue*	Data used to fill gaps in the swath	-999.000
source	Source of data	MOD03 geolocation product; data read from center pixel in 5 km box

* HDF predefined attribute names.

Quality Assessment

A revised approach to quality assessment (QA) was used in Collection 5. Instead of the spatial QA data being bit encoded flags, as was done in Collection 4 and prior collections, integer numbers are coded to convey the QA information. The QA data should be easier to use and gives a general indicator of good or other quality for the data. Data quality is determined by making the same checks as in C4 but the result is an integer value stored in the QA SDS.

The purpose of the spatial QA is to provide information each pixel that can be viewed in the same spatial context as the sea ice maps. The QA data may be used to help determine the usefulness of the sea ice and IST data.

Indicators of quality are also given in metadata objects in the CoreMetadata.0 global attribute generated during production, or in post-product scientific and quality checks of the data product. Of the few quality metadata objects in the CoreMetadata.0 global attribute only the ScienceQualityFlagExplanation is relevant as a pointer to website for science quality status. No automatic quality assessment is done in the algorithm production nor is science quality checked during production.

Sea_Ice_by_Reflectance_Pixel_QA

The quality assessment data provides an indication of the quality of the input data for the sea ice by reflectance algorithm. Data for a pixel are determined to be of good quality, other quality or may be set to a thematic value for certain conditions. Unless the input data is unusable or missing the data quality will usually be set to good. An example of the sea ice pixel QA is shown in Figure 3. Local attributes are listed in Table 8.

Table 8 Local Attributes with the *Sea_Ice_by_Reflectance_Pixel_QA*

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Sea ice by reflective characteristics spatial QA
units*	SI units of the data, if any	none

format*	How the data should be viewed, Fortran format notation	I3
coordsys*	Coordinate system to use for the data	Cartesian
valid_range*	Max and min values within a selected data range	0-254
_FillValue*	Data used to fill gaps in the swath	255
Key	Key to meaning of data in the SDS	0=good quality, 1=other quality, 252=Antarctica mask, 253=land mask, 254=ocean mask, 255=fill

* HDF predefined attribute names.

Ice_Surface_Temperature_Pixel_QA

The quality assessment data provides an indication of the quality of the input data for the IST algorithm. Data for a pixel are determined to be of good quality, other quality or may be set to a thematic value for certain conditions. MODIS bands 31 and 32 are checked to determine the quality of the IST. Unless the input data is unusable or missing the data quality will usually be set to good. An example of the IST pixel QA is shown in Figure 3. Local attributes are listed in Table 9.

Table 9. Local Attributes with *Ice_Surface_Temperature_Pixel_QA*

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Ice surface temperature pixel QA
units*	SI units of the data, if any	none
format*	How the data should be viewed, Fortran format notation	I3
coordsys*	Coordinate system to use for the data	Cartesian
valid_range*	Max and min values within a selected data range	0-254
_FillValue*	Data used to fill gaps in the swath	255
Key	Key to meaning of data in the SDS	0=good quality, 1=other quality, 252=Antarctica

		mask, 253=land mask, 254=ocean mask, 255=fill

* HDF predefined attribute names.

Sea Ice Accuracy and Errors

Sea ice extent has been evaluated through visual comparisons with MODIS radiance imagery and comparative analysis with sea ice products and maps from other sources. Though no definitive quantitative comparisons have been reported, qualitative evaluations suggest that under clear sky conditions the sea ice extent maps can be very accurate and show ice details at 1 km resolution. The extensive and frequent cloud cover in the Arctic is a factor against use of the MODIS data for monitoring sea ice conditions.

Land/Water Mask

The BU land/water mask which includes the Antarctica Digital Database to map the coastline of Antarctica is used in C5. Generally the coastlines are more accurately mapped and the ice shelves in Antarctica are mapped as in the ocean. In the previous land/water mask used in processing the ice shelves were mapped as on land and the coastline was inaccurate. Switch to the BU land/water mask was made in C4 thus there is discontinuity in mapping in C4. The land/water mask affects both the sea ice and IST products.

IST Accuracy and Errors

Under ideal conditions the IST accuracy is 1-3 K; see Hall et al. (2004) for discussion of the IST accuracy. Ideal conditions for the split-window technique are clear sky with low amount of water vapor. Water vapor causes decline in accuracy of the IST. Cloud detection is also a factor affecting accuracy, any clouds or partially cloudy conditions will decrease the accuracy of IST. IST accuracy has been evaluated in day time conditions only, no evaluation of night time IST has been done.

Global Attributes

There are 10 global attributes in the MOD29 product---three are ECS defined (CoreMetadata.0, ArchiveMetadata.0, and StructMetadata.0) and the others are specific to the product. These global attributes serve different purposes, such as search and order of products, mapping, and product version tracking and evaluating a product. The ECS defined attributes are written as very long character strings in parameter value language (PVL) format. Descriptions of the global attributes are given in the following tables.

CoreMetadata.0 and ArchiveMetadata.0 are global attributes in which information compiled about the product during product generation is archived. StructMetadata.0 contains information about the swath or grid mapping relevant to the product. A user wanting detailed explanations of the global attributes and related information should query the EOSDIS related web sites.

Table 10. Listing of objects in the global attribute CoreMetadata.0 in MOD29.

Object Name	Sample Value	Comment
LocalGranuleID	"MOD29.A2000307.1245.005.2006316035509.hdf"	Filename of product. Format is; EDST.Ayyyyddd.hhmm.vvv.yyyyddhhmmss.hdf

		Ayyyyddd.hhmm – acquisition date and time in UTC.
ProductionDateTime	"2006-11-12T03:56:09.000Z"	Date and time the file was produced. Format is; yyyy-mm-ddThh:mm:ss.sssZ
DayNightFlag	"Day"	Day means entire swath in daylight. Both means that part of swath lies in darkness. Night means entire swath in darkness.
ReprocessingActual	"reprocessed"	Reprocessed means data has been processed before. Processed once means this is the first processing of the data.
LocalVersionID	"SCF V5.0.1"	Version of algorithm delivered from the SCF.
ReprocessingPlanned	"further update is anticipated"	Expect that products will be reprocessed one or more times.
ScienceQualityFlag	"Not Investigated"	This is meaningless information. Original plan was for this metadata to be set/updated by investigator after evaluation/validation however that plan was dropped and this metadata is not set/updated. See ScienceQualityFlagExplanation for current information.
AutomaticQualityFLagExplanation	"No automatic quality assessment done in the PGE "	No automated QA checks made during execution of the algorithm.
AutomaticQualityFlag	"Passed"	Default setting because no automated QA checks are done.
ScienceIQualityFlagExplanation	"See http://landweb.nascom.nasa.gov/cgi-bin/QA_WWW/qaFlagPage.cgi?sat=terra for the product Science Quality status."	URL where updated information on science QA should be posted.
QAPercentMissingData	0	Amount of L1B data missing from the swath.
QAPercentCloudCover	51	Amount of land in the swath obscured by clouds.
ParameterName	"Sea_Ice_by_Reflectance",	QA parameters given apply to

	"Ice_Surface_Temperature"	the sea ice and IST data. Parameters stored in separate metadata containers.
EquatorCrossingDate	"2000-11-01"	Orbital parameter. Format; yyyy-mm-dd
EquatorCrossingTime	"21:36:54.673540"	Orbital parameter. Format; hh:mm:ss:ssssss
OrbitNumber	4653	Orbital parameter.
EquatorCrossingLongitude	-163.416015	Orbital parameter. Decimal degrees format.
VersionID	5	Indicates the EOSDIS Collection
ShortName	"MOD29"	ESDT name of product
GringPointLongitude	(-68.5013458531476, -21.2117998927236, -4.70595322433046, -104.809240942689)	These latitude and longitude pairs of points when connected in a clockwise series form a polygon of the swath coverage. Always represents the outer ring of coverage.
GringPointLatitude	(-59.523538004605, -66.2171885836562, -84.0881341715932, -69.8497509399292)	
GringPointSequenceNo	(1,2,3,4)	
ExclusionGRingFlag	"N"	
RangeEndingDate	"2000-11-02"	Beginning and ending times of the first and last scan line in the swath. Formats are; yyyy-mm-dd, hh:mm:ss.ssssss
RangeEndingTime	"12:50:00.000000"	
RangeBeginningDate	"2000-11-02"	
RangeBeginningTime	"12:45:00.000000"	
PGEVersion	"5.0.5"	Version of production generation executable.
InputPointer	("MOD02KM.A2000307.1245.005.2006315085748.hdf", MOD35_L2.A2000307.1245.005.2006315091041.hdf", MOD03.A2000307.1245.005.2006314120819.hdf")	Names of MODIS data input files.
AncillaryInputPointer	" MOD03.A2000307.1245.005.2006314120819.hdf "	Name of the geolocation file.
AncillaryInputType	"Geolocation"	Type of ancillary data referenced by pointer.

AssociatedSensorShortName	"MODIS"	Sensor name.
AssociatedPlatformShortName	"Terra"	Platform name.
AssociatedInstrumentShortName	"MODIS"	Instrument and sensor name are the same.
Product Specific Attributes (PSA)		
QAPERCENTGOODQUALITY	100	Summary quality of data range checks done in the algorithm.
QAPERCENTOTHERQUALITY	0	
GRANULENUMBER	155	Unique granule identifier
SEAICEPERCENT	49	Summary percentage of sea ice detected (0 – 100).

The ArchiveMetadata.0 global attribute contains information relevant to version of the algorithm, production environment and geographic location of the data product. Contents are described in Table 11.

Table 11. Listing of objects in the global attribute ArchiveMetadata.0 in MOD29.

Object Name	Typical Value	Comment
AlgorithmPackageAcceptanceDate	"05-2005"	Algorithm version information. Format is mm-yyyy.
AlgorithmPackageMaturityCode	"Normal"	
AlgorithmPackageName	"MOD_PR29"	
AlgorithmPackageVersion	"5"	
InstrumentName	"Moderate-Resolution Imaging SpectroRadiometer"	Long name of MODIS
Processing Center	"MODAPS"	MODIS Adaptive Processing System
ProcessingDateTime	"2001-01-22T16:41:07.000Z"	Date of processing. Format is; yyyy-mm-ddThh:mm:ss.sssZ
SPSOParameters	"none"	Archaic and meaningless.

LongName	"MODIS/Terra Sea Ice Extent 5-Min L2 Swath 1km"	Descriptive name of the product. May be displayed as the product name in the EOS Data Gateway or other dataset search tools.
LocalInputGranuleID	("MOD02KM.A2000307.1245.005.2006315 085748.hdf", MOD35_L2. A2000307.1245.005.2006315091041.hdf", MOD03. A2000307.1245.005.2006314120819.hdf")	Names of MODIS input files.
WestBoundingCoordinate	-104.569897414244	Eastern, western, northern, and southern most points of the swath. Format is decimal degrees.
NorthBoundingCoordinate	-59.5277468037003	
EastBoundingCoordinate	-6.17851446100517	
SouthBoundingCoordinate	-84.23292783622269	
Processing Environment	"Linux minion5049 2.6.8.1-26mdksmp #1 SMP Mon Nov 13 28:12:40 MST 2005 i686 Intel(R) Xeon(TM) CPU 2.80GHz unknown GNU/Linux"	Processing done in either UNIX or Linux environment.
DESCRRevison	"5.0"	Descriptor file associated with the PGE.

The StructMetadata.0 global attribute is created by the HDF-EOS toolkit to specify the mapping relationships between the geolocation data and the sea ice SDSs, referred to as data fields in the structural metadata. 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, DAAC tools or other software packages may be used to geolocate the data or to transform it to other projections and/or data file formats.

Listing of objects in the global attribute StructMetadata.0 in MOD29.

```
StructMetadata.0
GROUP=SwathStructure
     GROUP=SWATH_1
          SwathName="MOD_Swath_Sea_Ice"
          GROUP=Dimension
               OBJECT=Dimension_1
```

```
                    DimensionName="Coarse_swath_lines_5km"
                    Size=406
             END_OBJECT=Dimension_1
             OBJECT=Dimension_2
                    DimensionName="Coarse_swath_pixels_5km"
                    Size=271
             END_OBJECT=Dimension_2
             OBJECT=Dimension_3
                    DimensionName="Along_swath_lines_1km"
                    Size=2030
             END_OBJECT=Dimension_3
             OBJECT=Dimension_4
                    DimensionName="Cross_swath_pixels_1km"
                    Size=1354
             END_OBJECT=Dimension_4
         END_GROUP=Dimension
         GROUP=DimensionMap
             OBJECT=DimensionMap_1
                    GeoDimension="Coarse_swath_pixels_5km"
                    DataDimension="Cross_swath_pixels_1km"
                    Offset=2
                    Increment=5
             END_OBJECT=DimensionMap_1
             OBJECT=DimensionMap_2
                    GeoDimension="Coarse_swath_lines_5km"
                    DataDimension="Along_swath_lines_1km"
                    Offset=2
                    Increment=5
             END_OBJECT=DimensionMap_2
         END_GROUP=DimensionMap
         GROUP=IndexDimensionMap
         END_GROUP=IndexDimensionMap
         GROUP=GeoField
             OBJECT=GeoField_1
                    GeoFieldName="Latitude"
                    DataType=DFNT_FLOAT32
DimList=("Coarse_swath_lines_5km","Coarse_swath_pixels_5km")
             END_OBJECT=GeoField_1
             OBJECT=GeoField_2
                    GeoFieldName="Longitude"
                    DataType=DFNT_FLOAT32
DimList=("Coarse_swath_lines_5km","Coarse_swath_pixels_5km")
             END_OBJECT=GeoField_2
         END_GROUP=GeoField
         GROUP=DataField
             OBJECT=DataField_1
                    DataFieldName="Sea_Ice_by_Reflectance"
                    DataType=DFNT_UINT8
                    DimList=("Along_swath_lines_1km","Cross_swath_pixels_1km")
             END_OBJECT=DataField_1
```

```
                OBJECT=DataField_2
                        DataFieldName="Sea_Ice_by_Reflectance_Pixel_QA"
                        DataType=DFNT_UINT8
                        DimList=("Along_swath_lines_1km","Cross_swath_pixels_1km")
                END_OBJECT=DataField_2
                OBJECT=DataField_3
                        DataFieldName="Ice_Surface_Temperature"
                        DataType=DFNT_UINT16
                        DimList=("Along_swath_lines_1km","Cross_swath_pixels_1km")
                END_OBJECT=DataField_3
                OBJECT=DataField_4
                        DataFieldName="Ice_Surface_Temperature_Pixel_QA"
                        DataType=DFNT_UINT8
                        DimList=("Along_swath_lines_1km","Cross_swath_pixels_1km")
                END_OBJECT=DataField_4
        END_GROUP=DataField
        GROUP=MergedFields
        END_GROUP=MergedFields
    END_GROUP=SWATH_1
END_GROUP=SwathStructure
GROUP=GridStructure
END_GROUP=GridStructure
GROUP=PointStructure
END_GROUP=PointStructure
END
```

The other global attributes in the product are listed in Table 12.

Table 12 MOD29 product specific global attributes.

Attribute Name	Typical Value	Comment
HDFEOSVersion	HDFEOS_V2.9	Version of HDF_EOS toolkit used in PGE.
L1BCalibrationQuality	marginal	Quality indicators of MOD02HKM data.
L1BMissionPhase	EXECUTION	
L1BNadirPointing	Y	
L1BVersionID	2000-11-02	Version of the L1B processing algorithm.
L1BAutoQA_EV_1KM_RefsB	Suspect	Result of generalized quality analysis of L1B data
SCF Algorithm Version	"$Id: MOD_PR29_AA…"	Internal SCF version of the code modules.

MOD29PG

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 MOD29PGN 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 MOD29PG* is not archived at the DAAC thus is not available for order through ECS.

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.

MOD29P1D

The 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. There are two tile grids, one for the Northern Hemisphere and one for the Southern Hemisphere. Four SDSs 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 from the Level 2-G prouducts (Table 13). 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 = (0.5 * solar elevation) + (0.3 * observation coverage) + (0.2 * distance from nadir)
The input 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 both reflectance and thermal 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 and their corresponding QA data. In situations that include day and night data about the terminator in a tile the IST is mapped into the darkness of the terminator thus there may be regions with IST mapped without corresponding sea ice by reflectance data.

Table 13. MODIS data product inputs to the MODIS daily sea ice algorithm.

ESDT	Long Name	Data Used
MOD29PGD	MODIS/Terra Sea Ice Extent Daily L2G Global 1km EASE-Grid Day	Sea ice, IST and spatial QA.
MODMGPGD	MODIS/Terra Geolocation Angles Daily L2G Global 1km EASE-Grid Day	Solar and sensor geometry.

MODPTPGD	MODIS/Terra Observation Pointers Daily L2G Global 1km Polar Grid Day	Number of observations, coverage, observation swath and location.

Scientific Data Sets
Sea_Ice_By_Reflectance

The sea ice map is the result of selecting the most favorable observation of all the swath level observations mapped into a grid cell for the day. Mapped sea ice extent, land, water, cloud or other condition. A color-coded image of a snow map is shown in Figure 4. HDF predefined and custom local attributes are stored. The HDF predefined attributes may be used by some software packages. The custom local attributes are specific to the data in the SDS. Local attributes are listed in Table 14.

Table 14. Local attributes with the *Sea_Ice_by_Reflectance* SDS

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Sea ice by reflectance for daily tile
units*	SI units of the data, if any	none
format*	How the data should be viewed, Fortran format notation	I3
coordsys*	Coordinate system to use for the data	Cartesian
valid_range*	Max and min values within a selected data range	0-254
_FillValue*	Data used to fill gaps in the swath	255
Key	Key to meaning of data in the SDS	0=missing data, 1=no decision, 11=night, 25=land, 37=inland water, 39=ocean, 50=cloud, 200=sea ice, 253=land mask, 254=ocean mask, 255=fill

* HDF predefined attribute names.

Ice_Surface_Temperature

The IST map is the result of selecting the most favorable observation of all the swath level observations mapped into a grid cell for the day. Mapped are IST, land, water, cloud or other condition. A color-coded image of a snow map is shown in Figure 5. HDF predefined

and custom local attributes are stored with the SDS. The HDF predefined attributes may be used by some software packages. The custom local attributes are specific to the data in the SDS. Local attributes are listed in Table 15.

The IST 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").

IST is expressed in degrees Kelvin.

Table 15 Local attributes for *Ice_Surface_Temperature*

Attribute Name	Definition	Value
long_name*	Long Name of the SDS	Ice Surface Temperature for daily tile
units*	SI units of the data, if any	Degree_Kelvin
format*	How the data should be viewed, Fortran format notation	F4.1
coordsys*	Coordinate system to use for the data	cartesian
valid_range*	Max and min values within a selected data range	21000, 31300
_FillValue*	Data used to fill gaps in the swath	7
scale_factor*	Scale factor of calibrated data	0.010000
scale_factor_err*	Scale factor error of calibrated data	0.000000
add_offset*	Offset of calibrated data	0.000000
add_offset_err*	Offset error of calibrated data	0.000000
calibrated_nt*	Data type of calibrated data	5
Key	Key to meaning of data in the SDS	0.0=missing data, 1.0=no decision, 11.0=night, 25.0=land, 37.0=inland water, 39.0=open ocean, 50.0=cloud, 243.0-273.0 expected IST range, 655.35=fill

* HDF predefined attribute names.

Quality Assessment

Spatial QA data corresponding to the sea ice and IST observation selected for the daily snow cover map are also selected and mapped into the *Sea_Ice_by_Reflectance_Spatial_QA* and *Ice_Surface_Temperature_Spatial_QA* SDSs. These are reported in separates SDSs because one is based on visible data and the other on

thermal data. No automated quality assessment is done in this algorithm. All QA is inherited from the MOD29 product.

Sea_Ice_by_Reflectance_Spatial_QA
      Data on the quality of the selected observations is the L2 QA data corresponding to the observation selected for the day are mapped into this SDS. The local attributes are listed in Table 16.

Table 16. Local attributes for the *Sea_Ice_by_Reflectance_Spatial_QA* SDS

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Sea ice by reflectance spatial QA for daily tile
units*	SI units of the data, if any	none
format*	How the data should be viewed, Fortran format notation	I3
coordsys*	Coordinate system to use for the data	Cartesian
valid_range*	Max and min values within a selected data range	0-254
_FillValue*	Data used to fill gaps in the swath	255
Key	Key to meaning of data in the SDS	0=good quality, 1=other quality, 253=land mask, 254=ocean mask, 255=fill

* HDF predefined attribute names.

Ice_Surface_Temperature_Spatial_QA
Data on the quality of the selected observations is the L2 QA data corresponding to the IST observation selected for the day are mapped into this SDS. The local attributes are listed in Table 17.

Table 17. Local Attributes with *Ice_Surface_Temperature_Spatial _QA* SDS.

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Ice surface temperature spatial QA for daily tile
units*	SI units of the data, if any	none

format*	How the data should be viewed, Fortran format notation	I3
coordsys*	Coordinate system to use for the data	Cartesian
valid_range*	Max and min values within a selected data range	0-254
_FillValue*	Data used to fill gaps in the swath	255
Key	Key to meaning of data in the SDS	0=good quality, 1=other quality, 253=land mask, 254=ocean mask, 255=fill

* HDF predefined attribute names.

Sea Ice and IST Evaluation and Errors

      At this level the accuracy and errors are the same as found in the MOD29 product. Some minor mapping to grid/projection errors may occur in the product. Qualitatively the sea ice and IST products are of good quality based on qualitative comparisons with external data sources. Significant quantitative analysis has not been undertaken.

Global Attributes

      There are six global attributes in the MOD29P1D product, three are ECS defined (CoreMetadata.0, ArchiveMetadata.0, and StructMetadata.0) and the others are specific to the product. These global attributes serve different purposes, such as search and order of products, mapping, and product version tracking and evaluating a product. The ECS defined attributes are written as very long character strings in parameter value language (PVL) format. Descriptions of the global attributes are given in the following tables. CoreMetadata.0 and ArchiveMetadata.0 are global attributes in which information compiled about the product during product generation is archived. StructMetadata.0 contains information about the swath or grid mapping relevant to the product. A user wanting detailed explanations of the global attributes and related information should query the EOSDIS related web sites.

Table 18. CoreMetadata.0 of the MOD29P1D data product.

Object Name	Sample Value	Comment
LocalGranuleID	"MOD29P1D.A2000093.h08v06.005.2006260100138.hdf"	Filename of product. Format is; EDST.Ayyyyddd.hnnvnn.vvv.yyyydddhhmmss.hdf Ayyyyddd.hhmm – acquisition date and time in UTC. hnnvnn – horizontal and vertical tile number vvv – collection version

		yyyydddhhmmss – date and time of production hdf – HDF file extension
ProductionDateTime	"2006-09-17T10:01:42.000Z"	Date and time the file was produced. Format is; yyyy-mm-ddThh:mm:ss.sssZ
DayNightFlag	"Day"	Day means entire swath in daylight. Both means that some thermal data from darkness is included.
ReprocessingActual	"reprocessed"	Reprocessed means data has been processed before. Processed once means this is the first processing of the data.
LocalVersionID	"SCF 5.0.0"	Version of algorithm delivered from the SCF.
ReprocessingPlanned	"further update is anticipated"	Expect that the product will be reprocessed again with an improved algorithm.
ScienceQualityFlag	"Not investigated"	This is meaningless information. Original plan was for this metadata to be set/updated by investigator after evaluation/validation however that plan was dropped and this metadata is not set/updated. See ScienceQualityFlagExplanation for current information.
AutomaticQualityFlagExplanation	"No automatic quality assessment done in the PGE"	No automated QA checks made during execution of the algorithm.
AutomaticQualityFlag	"Passed"	Default setting because no automated QA checks are done.
ScienceQualityFlagExplanation	"See http://landweb.nascom/nasa.gov/cgi-bin/QA_WWW/qaFlagPage.cgi?sat=terra for the product Science Quality status."	URL where updated information on science QA should be posted.
QAPercentMissingData	0	Amount of data missing from the swath.
QAPercentCloudCover	4	Amount of ocean in the swath obscured by clouds.

ParameterName	"Sea_Ice_by_Reflectance" "Ice_Surface_Temperature"	Two parameters for which QA statistics are given.
EquatorCrossingDate	2000-04-02	Orbital parameters Format; yyyy-mm-dd, Format; hh:mm:ss:ssssss, Decimal degrees format. Data given for each swath input.
EquatorCrossingTime	21:20:53.835055	
OrbitNumber	1551	
EquatorCrossing Longitude	-158.930203823431	
VersionID	1	Indicates the EOSDIS Collection
ShortName	"MOD29P1D"	ESDT name of product
InputPointer	(“MOD29PGD.A2000093.h08v06.005.2006260100122.hdf”, MODPTPGD. A2000093.h08v06.005.2006260100018.hdf”, MODMGPGD. A2000093.h08v06.005.2006260100046.hdf”	Names of MODIS data input files.
GringPointLongitude	(-156.801409485362, -171.869897645844, -168.69006752598, -149.036243467926)	These latitude and longitude pairs of points when connected in a clockwise series form a polygon of the swath coverage. Always represents the outer ring of coverage.
GringPointLatitude	(56.887169891379, 59.3162347772988, 68.0022229499443, 64.7960762144739)	
GringPointSequenceNo	(1, 2, 3, 4)	
ExclusionGRingFlag	"N"	
RangeEndingDate	"2000-04-02"	Beginning and ending times of the first and last scan line in the swath. Formats are; yyyy-mm-dd, hh:mm:ss.ssssss
RangeEndingTime	"22:45:00.000000 "	
RangeBeginningDate	"2000-12-25"	
RangeBeginningTime	"01:10:00.000000 "	
PGEVersion	"5.0.2"	Version of production generation executable (PGE).
AssociatedSensorShortName	"MODIS"	Sensor name.
AssociatedPlatformShortName	"Terra"	Platform name.

AssociatedInstrumentShortName	"MODIS"	Instrument and sensor name are the same.
Product Specific Attributes (PSA)		
QAPERCENTGOODQUALITY	39	Summary quality of data range checks done in the algorithm.
QAPERCENTOTHERQUALITY	61	
HORIZONTALTILENUMBER	"08"	In longitude direction (NP:0-18, SP 0-18)
VERTICALTILENUMBER	"06"	In latitude direction (NP:0-18, SP 20-38)
TileID	"31008006"	Format is;pshhhvvv p – projection code s – size (1 is full size) hhh – horizontal tile number vvv – vertical tile number
SEAICEPERCENT	35	Summary percentage of sea ice.

The ArchiveMetadata.0 global attribute contains information relevant to version of the algorithm, production environment and geographic location of the data product. Contents are described in Table 19.

Table 19. Listing of objects in the ArchiveMetadata.0 in the MOD29P1D data product.

Object Name	Sample Value	Comment
CharacteristicBinAngularSize	71.7250539598207	
CharacteristicBinSize	1.00270100e+03	
GEOAnyAbnormal	"False"	
GEOEstMaxRMSError	50.000000	Estimated maximum error in geolocation of the data in meters
DataColumns	951	Columns in tile
DataRows	951	Rows in tile
GlobalGridColumns	18069	Columns across global grid
GlobalGridRows	18069	Rows across global grid
Numberofoverlapgranules	4	Number of staged

		granules that were mapped into this tile.
Numberofinputgranules	18	Total number of MOD29input granules staged.
Coveragecalculationmethod	"volume"	
AlgorithmPackageAcceptanceDate	"10-2004"	Algorithm version information. Format is mm-yyyy.
AlgorithmPackageMaturityCode	"Normal"	
AlgorithmPackageName	"MOD_PR29A1"	
AlgorithmPackageVersion	"5"	
LongName	"MODIS/Terra Sea Ice Extent Daily L3 Global 1km EASE-Grid Day"	Descriptive name of the product. May be displayed as the product name in the EOS Data Gateway or other dataset search tools.
InstrumentName	"Moderate-Resolution Imaging SpectroRadiometer"	
PlatformShortName	"Terra"	
LocalInputGranuleID	"MOD29PGD.A2000093.h08v06.005.2006260100122.hdf", MODPTPGD. A2000093.h08v06.005.2006260100018.hdf", MODMGPGD. A2000093.h08v06.005.2006260100046.hdf"	Names of MODIS input files.
ProcessingCenter	"MODAPS"	MODIS Adaptive Processing System
ProcessingDateTime	"2006-09-17T10:01:38.000Z"	Date of processing. Format is; yyyy-mm-ddThh:mm:ss.sssZ
SPSOParameters	"none"	Archaic and meaningless.

NorthBoundingCoordinate	68.0022229499443	Eastern, western, northern, and southern most points of the swath. Format is decimal degrees.
SouthBoundingCoordinate	56.8871693891379	
EastBoundingCoordinate	-149.036243467926	
WestBoundingCoordinate	-171.869897645844	
Processing Environment	"Linux minion5072 2.6.8.1-26mdksmp #1 SMP Mon Nov 28 12:40:04 MST 2005 i686 Intel ® Xeon™ CPU 2.80GHz unknown GNU/Linux"	Processing done in either UNIX or Linux environment.
DESCRRevision	"5.0"	Descriptor file associated with the PGE.

The StructMetadata.0 global attribute is created by the HDF-EOS toolkit to specify the mapping relationships between the map projection and the sea ice 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, DAAC tools or other software packages may be used to geolocate the data or to transform it to other projections.   Map projection parameters are from the GCTP.

Listing of the global attribute StructMetadata.0 in MOD29P1D.StructMetadata.0
GROUP=SwathStructure
END_GROUP=SwathStructure
GROUP=GridStructure
        GROUP=GRID_1
                GridName="MOD_Grid_Seaice_1km"
                XDim=951
                YDim=951
                UpperLeftPointMtrs=(-1430352.976500,3337490.278500)
                LowerRightMtrs=(-476784.325500,2383921.627500)
                Projection=GCTP_LAMAZ
                ProjParams=(6371228,0,0,0,0,90000000,0,0,0,0,0,0,0)
                SphereCode=-1
                GridOrigin=HDFE_GD_UL
                GROUP=Dimension
                END_GROUP=Dimension
                GROUP=DataField
                        OBJECT=DataField_1
                                DataFieldName="Sea_Ice_by_Reflectance"
                                DataType=DFNT_UINT8
                                DimList=("YDim","XDim")
                                CompressionType=HDFE_COMP_DEFLATE
                                DeflateLevel=9
                        END_OBJECT=DataField_1
                        OBJECT=DataField_2

```
                    DataFieldName="Sea_Ice_by_Reflectance_Spatial_QA"
                    DataType=DFNT_UINT8
                    DimList=("YDim","XDim")
                    CompressionType=HDFE_COMP_DEFLATE
                    DeflateLevel=9
            END_OBJECT=DataField_2
            OBJECT=DataField_3
                    DataFieldName="Ice_Surface_Temperature"
                    DataType=DFNT_UINT16
                    DimList=("YDim","XDim")
                    CompressionType=HDFE_COMP_DEFLATE
                    DeflateLevel=9
            END_OBJECT=DataField_3
            OBJECT=DataField_4
                    DataFieldName="Ice_Surface_Temperature_Spatial_QA"
                    DataType=DFNT_UINT8
                    DimList=("YDim","XDim")
                    CompressionType=HDFE_COMP_DEFLATE
                    DeflateLevel=9
            END_OBJECT=DataField_4
        END_GROUP=DataField
        GROUP=MergedFields
        END_GROUP=MergedFields
    END_GROUP=GRID_1
END_GROUP=GridStructure
GROUP=PointStructure
END_GROUP=PointStructure
END
```

Other global attributes in the product are listed in Table 20.

Table 20. Other global attributes in MOD29P1D.

Attribute Name	Sample Value	Comment
HDFEOSVersion	HDFEOS_V2.9	Version of HDF_EOS toolkit used in PGE.
SCF Algorithm Version	$id: MOD_PR29A1…	Internal SCF version of the code modules.
MOD29InputGranuleNames	["MOD29.A200036…",…]	Listing of MOD29 input files used in the data product.

MOD29P1N

This product contains only the ice surface temperature (IST) data processed from MODIS thermal data acquired during night mode operation of the sensor. Two 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.

<u>Algorithm Description</u>

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 = (0.3 * observation coverage) + (0.2 * distance from nadir)

These data are read from the L2G products of sea ice (MOD29PGN) and pointer (MODPTPGN). All observations for a day are scored and the one with the highest score is selected as the observation for the day.

<u>Scientific Data Sets</u>
Ice_Surface_Temperature

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).

Table 21. Local attributes with the *Ice_Surface_Tempertature* SDS.

Attribute Name	Definition	Value
long_name*	Long Name of the SDS	Ice Surface Temperature for daily tile
units*	SI units of the data, if any	Degree_Kelvin
format*	How the data should be viewed, Fortran format notation	F4.1
coordsys*	Coordinate system to use for the data	cartesian
valid_range*	Max and min values within a selected data range	21000, 31300
_FillValue*	Data used to fill gaps in the swath	7
scale_factor*	Scale factor of calibrated data	0.010000
scale_factor_err*	Scale factor error of calibrated data	0.000000
add_offset*	Offset of calibrated data	0.000000
add_offset_err*	Offset error of calibrated data	0.000000
calibrated_nt*	Data type of calibrated data	23
Key	Key to meaning of data in the SDS	0.0=missing data, 1.0=no decision, 11.0=night, 25.0=land, 37.0=inland water, 39.0=open ocean, 50.0=cloud, 243.0-273.0 expected IST range, 655.35=fill

* HDF predefined attribute names.

<u>Quality Assessment</u>
Quality Assessment data is carried forwared from the input data products to the output product.   No automated assessment is done in the algorithm during production.

Ice_Surface_Temperature_Spatial_QA
Spatial QA data corresponding to the selected ice surface temperature observation is mapped into the Ice_Surface_Temperature_Spa tial_QA SDS.

Table 22. Local Attributes with *Ice_Surface_Temperature_Spatial _QA* SDS.

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Ice surface temperature spatial QA for daily tile
units*	SI units of the data, if any	none
format*	How the data should be viewed, Fortran format notation	I3
coordsys*	Coordinate system to use for the data	Cartesian
valid_range*	Max and min values within a selected data range	0-254
_FillValue*	Data used to fill gaps in the swath	255
Key	Key to meaning of data in the SDS	0=good quality, 1=other quality, 253=land mask, 254=ocean mask, 255=fill

* HDF predefined attribute names.

<u>IST Evaluation and Errors</u>
Depending on location and time of the year the night product may sometimes contain only fill data. For example, during the peak of boreal summer in the Arctic there may only be day or day and night swaths thus there may not be any night only swaths acquired to map into the night product so it is filled with a fill value.

Superficial evaluation of the nighttime IST indicates that usability of the product is greatly impacted by difficulties encountered in attempting to accurately detect cloud at night in polar regions. There are many difficulties to be resolved on the way to improving the night cloud detection in polar regions in the cloud mask algorithm. Despite the challenge of nighttime cloud detection the nighttime IST may sometimes provide a view of sea ice at night. Sometimes textures of IST at night are similar to textures observed in daylight, c.f. Fig. 5A to Fig. 5 or Fig. 6. However it is also apparent that some regions of IST appear more

characteristic of cloud that IST and that cloud maybe speckled over the entire extent of IST at night. Mapping or gridding artifacts, e.g. linear banding or checkerboard appearance of features, frequently appear in the product. The potential usability of the nighttime IST has yet to be thoroughly investigated.

Global Attributes
The global attributes in MOD29P1N are the same as in MOD29P1D. Refer to Tables 18 and 19 and the listing of StructMetadata.0 for a listing of the global attributes. Content of some of the attributes germane to the night product is changed accordingly.

MOD29E1D
The global daily level-3 sea ice product containing sea ice extent and ice surface temperature (IST) is in EASE-Grid polar projection at approximately 4 km spatial resolution. Polar projections for both poles are in the data product; data arrays have dimensions of 4321 x 4321 elements. The product contains four SDSs with local attributes and four global attributes that contain the ECS metadata or other data.

Algorithm Description
Input to the daily global sea ice algorithm is the daily sea ice product (MOD29P1D). There are nominally 121 input tiles for the Northern Hemisphere and 76 for the Southern Hemisphere. Input data at approximately 1 km resolution are mapped to an input polar grid of 1 km resolution then that input grid is mapped onto the output grid of approximately 4 km resolution. The output grid is modeled on the EASE-Grid projection. 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 an output grid cell.

Scientific Data Sets
Sea_Ice_by_Reflectance_NP and *Sea_Ice_by_Reflectance_SP*
Extent of sea ice as determined by reflectance characteristics is mapped in this SDS. The observation stored is the one that was mapped into the center of the output grid from the input grid of the daily tiled sea ice products. Local attributes are listed in Table 23.

Table 23. Local attributes for the *Sea_Ice_by_Reflectance_NP* and *Sea_Ice_by_Reflectance_SP* SDSs

Attribute name	Definition	Value
long_name*	Long Name of the SDS	Sea ice by reflectance 4 km global North Pole grid OR Sea ice by reflectance 4 km global South Pole grid
units*	SI units of the data, if any	none
coordsys*	Coordinate system to use for the data	Cartesian
valid_range*	Max and min values within a selected data range	0-254

_FillValue*	Data used to fill gaps in the swath	255
Missing_value	For missing data	0
Key	Key to meaning of data in the SDS	0=missing data, 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

* HDF predefined attribute names.

Ice_Surface_Temperature_NP and *Ice_Surface_Temperature_NP* SDSs

Ice surface temperature (IST) in Kelvin is mapped in this SDS. The observation stored is the one that was mapped into the center of the output grid from the input grid of the daily tiled sea ice products. IST data are stored as scaled integers and must be descaled using the scale factor data. The scale factor is 0.01. Multiplying the scaled data by the scale factor will produce correct IST data. Valid range of IST is 210.00 – 313.20K. Local attributes are listed in Table 24.

Table 24 Local attributes for the *Ice_Surface_Temperature_NP* and *Ice_Surface_Temperature_SP* SDSs.

Attribute Name	Definition	Value
long_name*	Long Name of the SDS	Estimated sea ice surface temperature 4 km North Pole grid OR Estimated sea ice surface temperature 4 km South Pole grid
units*	SI units of the data, if any	degree_Kelvin
format*	How the data should be viewed, Fortran format notation	F4.1
coordsys*	Coordinate system to use for the data	cartesian
valid_range*	Max and min values within a selected data range	22320, 31320
_FillValue*	Data used to fill gaps in the swath	7
Missing_value	For missing data	0
scale_factor*	Scale factor of calibrated data	0.010000

scale_factor_err*	Scale factor error of calibrated data	0.000000
add_offset*	Offset of calibrated data	0.000000
add_offset_err*	Offset error of calibrated data	0.000000
calibrated_nt*	Data type of calibrated data	23
Key	Key to meaning of data in the SDS	0.0=missing data, 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

* HDF predefined attribute names.

Quality Assessment

Minimal quality assessment (QA) has been applied in the first release version of the data product. Summary QA data is reported in the metadata. Special data values are written in the product for some situations (see SDS descriptions). Spatial QA SDS data are not included in the product. Expect that reporting of quality assessment data will change in the future based on further evaluation and validation of the product.

Sea Ice and IST Evaluation and Errors

The global products appear to give reasonable maps of sea ice extent and IST however, no qualitative or quantitative analysis has been done to firmly establish the accuracy of the products.

Global Attributes

Three ECS global attributes and one 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 25 and 26.

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 25.

Table 25. CoreMetadata.0 of the MOD29E1D data product.

Object Name	Sample Value	Comment
LocalGranuleID	"MOD29E1D.A2000080.005.2006258094236.hdf	Filename of product. Format is; EDST.Ayyyyddd. vvv.yyyydddhhmmss.hdf Ayyyyddd.hhmm – acquisition date and time in UTC. vvv – collection version yyyydddhhmmss – date and time of production

		hdf – HDF file extension
ProductionDateTime	"2006-09-15T09:42:36.000Z"	Date and time the file was produced. Format is; yyyy-mm-ddThh:mm:ss.sssZ
DayNightFlag	"Day"	Day means all data in daylight. Both means that daylight and darkness were included.
ReprocessingActual	"reprocessed"	Reprocessed means data has been processed before. Processed once means this is the first processing of the data.
LocalVersionID	"SCF V5.0.0"	Version of algorithm delivered from the SCF
ReprocessingPlanned	"further update is anticipated"	Expect that the product will be reprocessed again with an improved algorithm
ScienceQualityFlag	"Not Investigated"	This is meaningless information. Original plan was for this metadata to be set/updated by investigator after evaluation/validation however that plan was dropped and this metadata is not set/updated. See ScienceQualityFlagExplanation for current information.
AutomaticQualityFlagExplanation	"No automatic quality assessment done in the PGE"	No automated QA checks made during execution of the algorithm.
AutomaticQualityFlag	"Passed"	Default setting because no automated QA checks are done.
ScienceQualityFlagExplanation	"See http://landweb.nascom/nasa.gov/cgi-bin/QA_WWW/qaFlagPage.cgi?sat=terra the product Science Quality status."	URL where updated information on science QA should be posted.
QAPercentMissingData	0	Amount of data missing from the swath.
QAPercentCloudCover	34	Amount of land in the

		swath obscured by clouds.
ParameterName	"Sea_Ice_by_Reflectance_NP", "Ice_Surface_Temperature_NP", "Sea_Ice_by_Reflectance_SP", "Ice_Surface_Temperature_SP"	Parameters for which QA statistics are given. Four containers containing the preceding six objects of QA statistics used.
VersionID	5	ESC Version
ShortName	"MOD29E1D"	ESDT name of product
InputPointer	MOD29P1D…"	Names of input file, typically about 210 files.
EastBoundingCoordinate	180.000000	Global coverage.
WestBoundingCoordinate	-180.000000	
SouthBoundingCoordinate	-90.000000	
NorthBoundingCoordinate	90.000000	
LocalityValue	"Global"	
RangeEndingDate	"2000-03-20"	Beginning and ending times set to include the entire 24 hour period.
RangeEndingTime	"23:59:59.000000 "	
RangeBeginningDate	"2000-03-20"	
RangeBeginningTime	"00:00:00.000000 "	
PGEVersion	"5.0.4"	Version of production generation executable (PGE).
AssociatedSensor ShortName	"MODIS"	Sensor name.
AssociatedPlatform ShortName	"Terra"	Platform name.
AssociatedInstrument ShortName	"MODIS"	Instrument and sensor name are the same.

The ECS global attribute ArchiveMetadata.0 contains information relevant to the algorithm and processing environment. A listing of objects along with sample values is given in Table 26.

Table 26. ArchiveMetadata.0 of the MOD29E1D data product.

Object Name	Sample Value	Comment
CharacteristicBinAngularSize	287.936014219062	
CharacteristicBinSize	4.01080400e+03	
GlobalGridColumns	4501	
GlobalGridRows	4501	
NumberOfInputGranules	210	Total number of MOD29P1D input granules.
AlgorithmPackageAcceptanceDate	"12-2004"	Algorithm version information. Format
AlgorithmPackageMaturityCode	"Normal"	

AlgorithmPackageName	"MOD_PR29E1"	is mm yyyy.
AlgorithmPackageVersion	"5"	
LongName	"MODIS/Terra Sea Ice Extent and IST Daily L3 Global 4km EASE-Grid Day"	Descriptive name of the product. May be displayed as the product name in the EOS Data Gateway or other dataset search tools.
InstrumentName	"Moderate-Resolution Imaging SpectroRadiometer"	
PlatformShortName	"Terra"	
ProcessingCenter	"MODAPS"	MODIS Adaptive Processing System
ProcessingDateTime	"2006-09-15T05:42:29.000Z"	Date of processing. Format is; yyyy-mm-ddThh:mm:ss.sssZ
SPSOParameters	"none"	Archaic and meaningless.
ProcessingEnvironment	"IRIX64 mtvs3 6.5 10070055 IP35"	Processing done in either UNIX or Linux environment.

The StructMetadata.0 global attribute is created by the HDF-EOS toolkit to specify the mapping relationships between the map projection data and the snow cover 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, DAAC tools or other software packages may be used to map the data or to transform it to other projections.   Map projection parameters are from the GCTP.

Listing of the global attribute StructMetadata.0 in MOD29E1D StructMetadata.0.

```
GROUP=SwathStructure
END_GROUP=SwathStructure
GROUP=GridStructure
    GROUP=GRID_1
        GridName="MOD_Grid_Seaice_4km_North"
        XDim=4501
        YDim=4501
        UpperLeftPointMtrs=(-9026314.402000,9026314.402000)
        LowerRightMtrs=(9026314.402000,-9026314.402000)
        Projection=GCTP_LAMAZ
        ProjParams=(6371228,0,0,0,0,90000000,0,0,0,0,0,0,0)
        SphereCode=0
        GridOrigin=HDFE_GD_UL
        GROUP=Dimension
        END_GROUP=Dimension
```

```
        GROUP=DataField
            OBJECT=DataField_1
                DataFieldName="Sea_Ice_by_Reflectance_NP"
                DataType=DFNT_UINT8
                DimList=("XDim","YDim")
                CompressionType=HDFE_COMP_DEFLATE
                DeflateLevel=9
            END_OBJECT=DataField_1
            OBJECT=DataField_2
                DataFieldName="Ice_Surface_Temperature_NP"
                DataType=DFNT_UINT16
                DimList=("XDim","YDim")
                CompressionType=HDFE_COMP_DEFLATE
                DeflateLevel=9
            END_OBJECT=DataField_2
        END_GROUP=DataField
        GROUP=MergedFields
        END_GROUP=MergedFields
    END_GROUP=GRID_1
    GROUP=GRID_2
        GridName="MOD_Grid_Seaice_4km_South"
        XDim=4501
        YDim=4501
        UpperLeftPointMtrs=(-9026314.402000,9026314.402000)
        LowerRightMtrs=(9026314.402000,-9026314.402000)
        Projection=GCTP_LAMAZ
        ProjParams=(6371228,0,0,0,0,-90000000,0,0,0,0,0,0,0)
        SphereCode=0
        GridOrigin=HDFE_GD_UL
        GROUP=Dimension
        END_GROUP=Dimension
        GROUP=DataField
            OBJECT=DataField_1
                DataFieldName="Sea_Ice_by_Reflectance_SP"
                DataType=DFNT_UINT8
                DimList=("XDim","YDim")
                CompressionType=HDFE_COMP_DEFLATE
                DeflateLevel=9
            END_OBJECT=DataField_1
            OBJECT=DataField_2
                DataFieldName="Ice_Surface_Temperature_SP"
                DataType=DFNT_UINT16
                DimList=("XDim","YDim")
                CompressionType=HDFE_COMP_DEFLATE
                DeflateLevel=9
            END_OBJECT=DataField_2
        END_GROUP=DataField
        GROUP=MergedFields
        END_GROUP=MergedFields
    END_GROUP=GRID_2
```

END_GROUP=GridStructure
GROUP=PointStructure
END_GROUP=PointStructure
END

Other global attributes in the product are listed in Table 27.

Table 27. MOD29E1D product specific global attributes.

Attribute Name	Sample Value	Comment
HDFEOSVersion	"HDFEOS_V2.9"	Version of HDF_EOS toolkit.

Figures

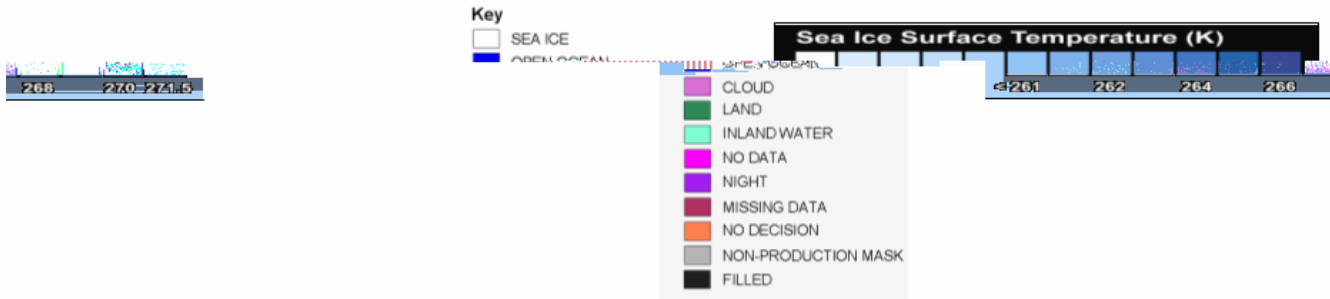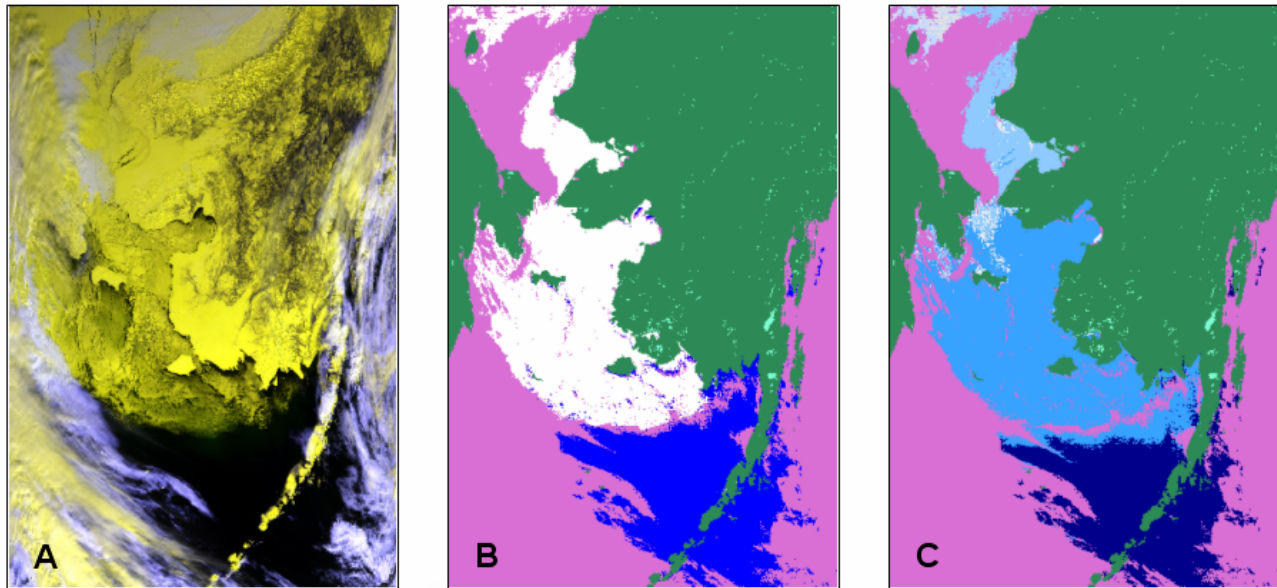Figure 1. MOD29 sea ice (B) and IST maps (C) from 2003 093 2240 UTC alongside a visible image of MODIS bands 1,4,6 from MOD021KM (A). Images are not projected.

Key

☐	SEA ICE
◼	OPEN OCEAN
◼	CLOUD
◼	LAND
◼	INLAND WATER
◼	NO DATA
◼	NIGHT
◼	MISSING DATA
◼	NO DECISION
◼	NON-PRODUCTION MASK
◼	FILLED

Sea Ice Surface Temperature (K)

268 270 271.5

<261 262 264 266

Figure 2. MOD29 2003 093 2240 UTC sea ice extent in Lambert Azimuthal equal area projection.

Key

	SEA ICE
	OPEN OCEAN
	CLOUD
	LAND
	INLAND WATER
	NO DATA
	NIGHT
	MISSING DATA
	NO DECISION
	NON-PRODUCTION
	FILLED
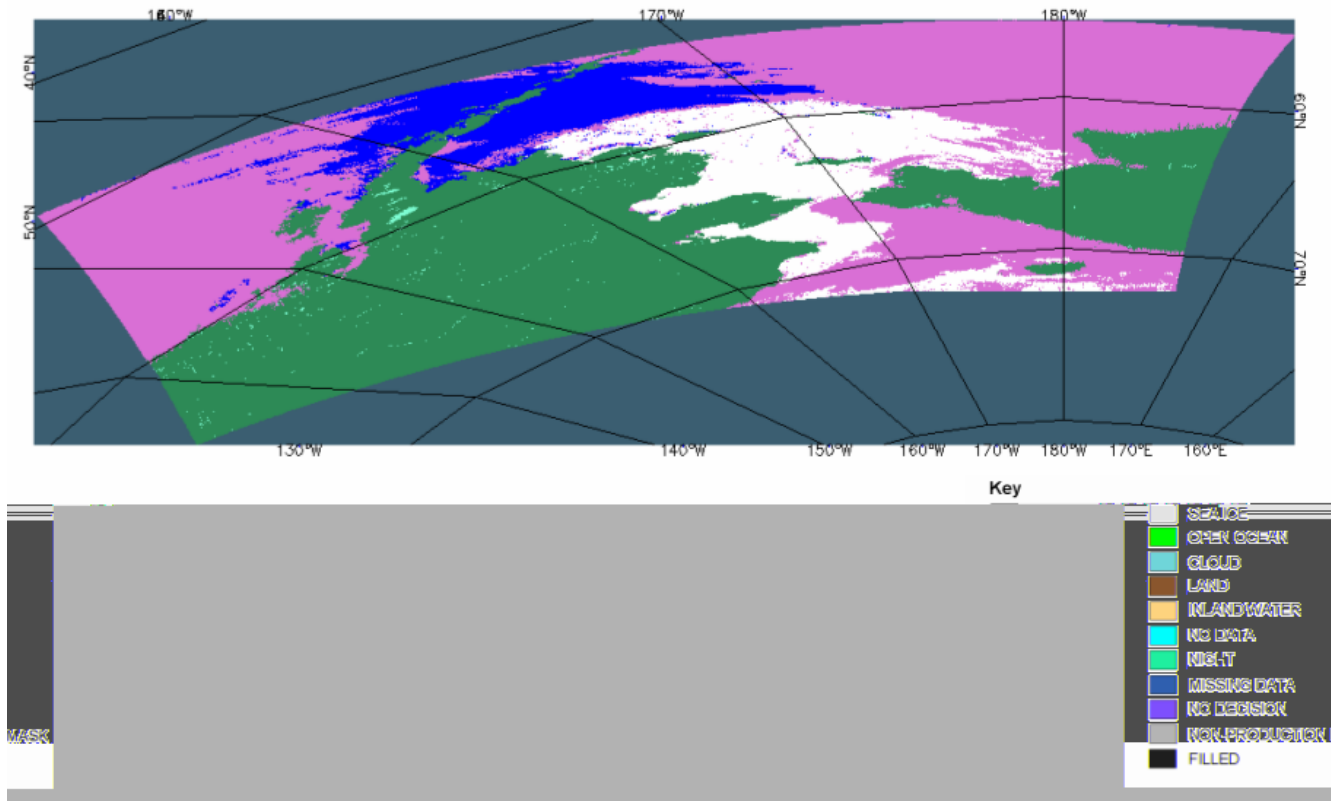
Figure 3. MOD29 sea ice (A) and IST maps (B) from 2003 093 2240 UTC shown alongside the QA maps for each in C and D respectively. (Images are not projected.)

Figure 4. MOD29P1D map of sea ice extent from 2 April 2000 for polar tile h08v06 (Lambert Azimuthal Projection). (The latitude and longitude are incorrectly labeled due to different map origins between product and toolkit use for the projection.)

Key
☐ SEA ICE
☐ OPEN OCEAN
☐ CLOUD
☐ LAND
☐ INLAND WATER
☐ NO DATA
☐ NIGHT
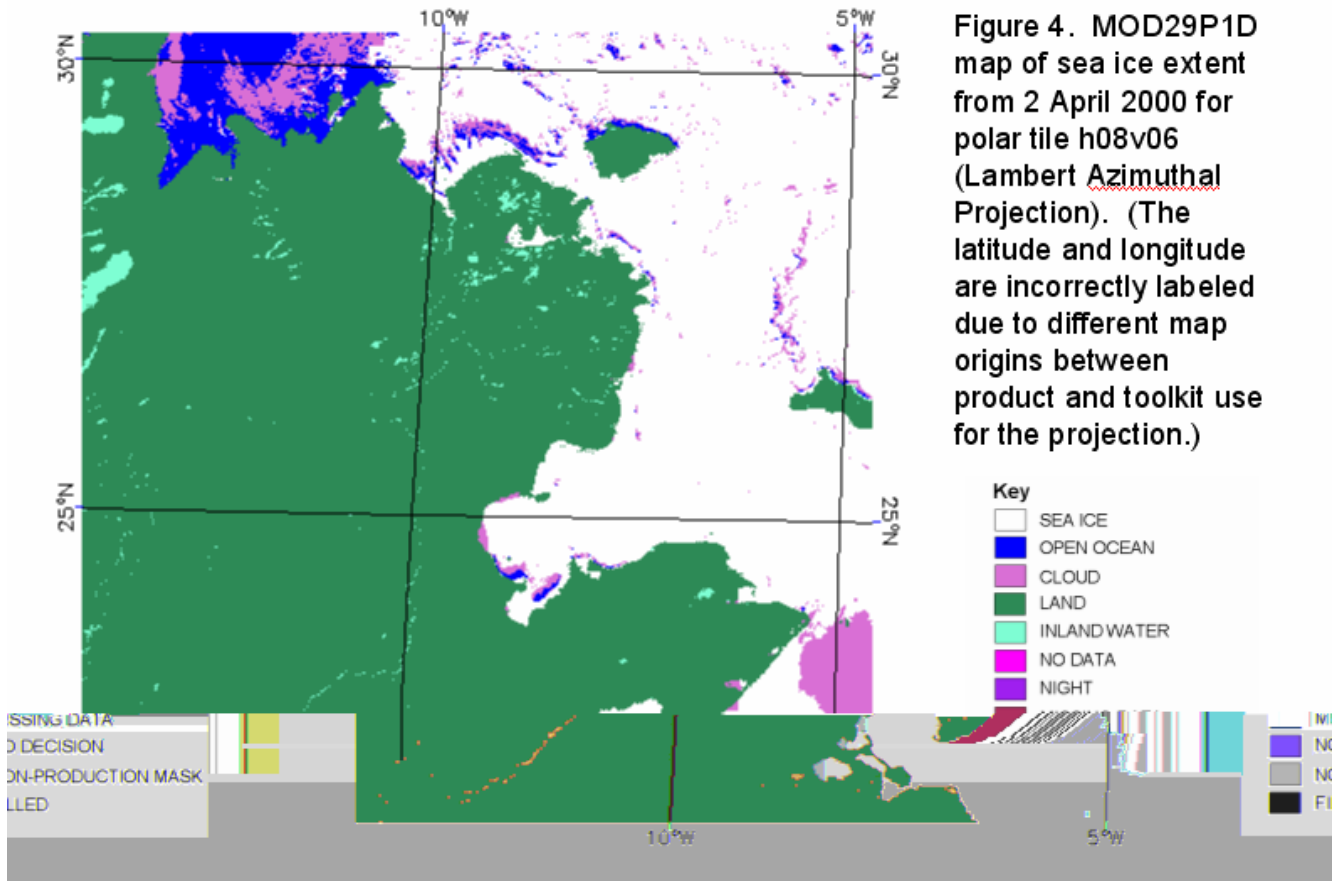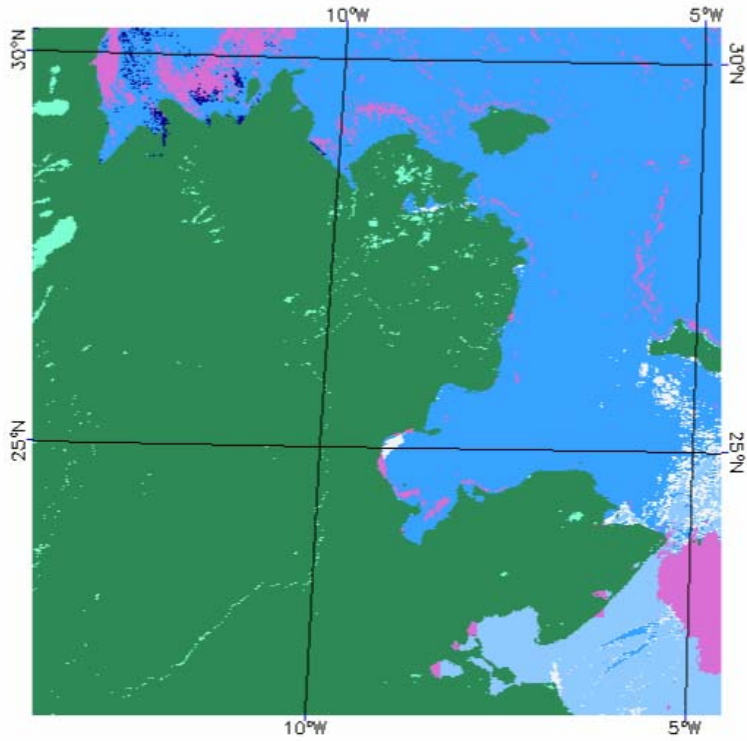
Figure 5. MOD29P1D map of IST from 2 April 2000 for polar tile h08v06 (Lambert Azimuthal Projection). (The latitude and longitude are incorrectly labeled due to different map origins between product and toolkit use for the projection.)

IST color coded ranges

>230 - <250	>250 - <253	>253 - <256	>256 - <259	>259 - <262	>262 - <265	>265 - <268	>268 - <271	>271
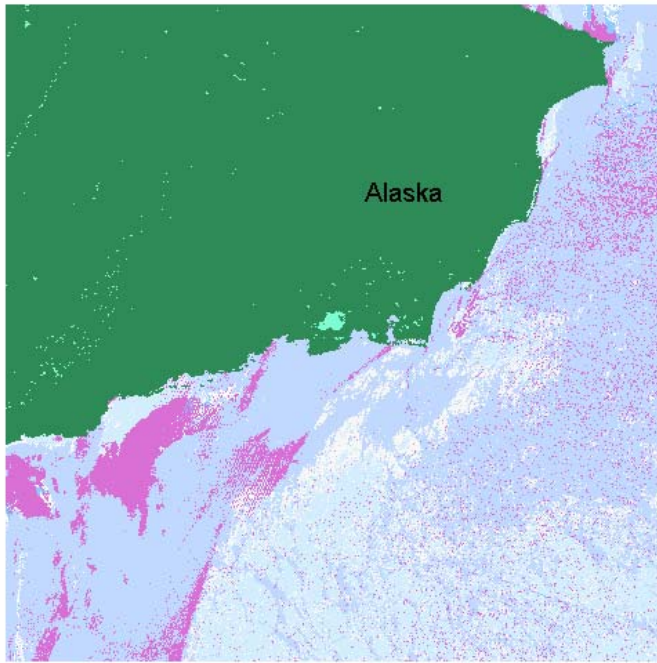
Figure 5A. Nighttime IST map, Lambert Azimuthal projection, from MYD29P1N for 4 January 2007 tile h08v07. Northern and northwestern Alaska included in this polar tile.

Key

☐	SEA ICE
■	OPEN OCEAN
■	CLOUD
■	LAND
■	INLAND WATER
■	NO DATA
■	NIGHT
■	MISSING DATA
■	NO DECISION
■	NON-PRODUCTION MASK
■	FILLED

IST color coded ranges

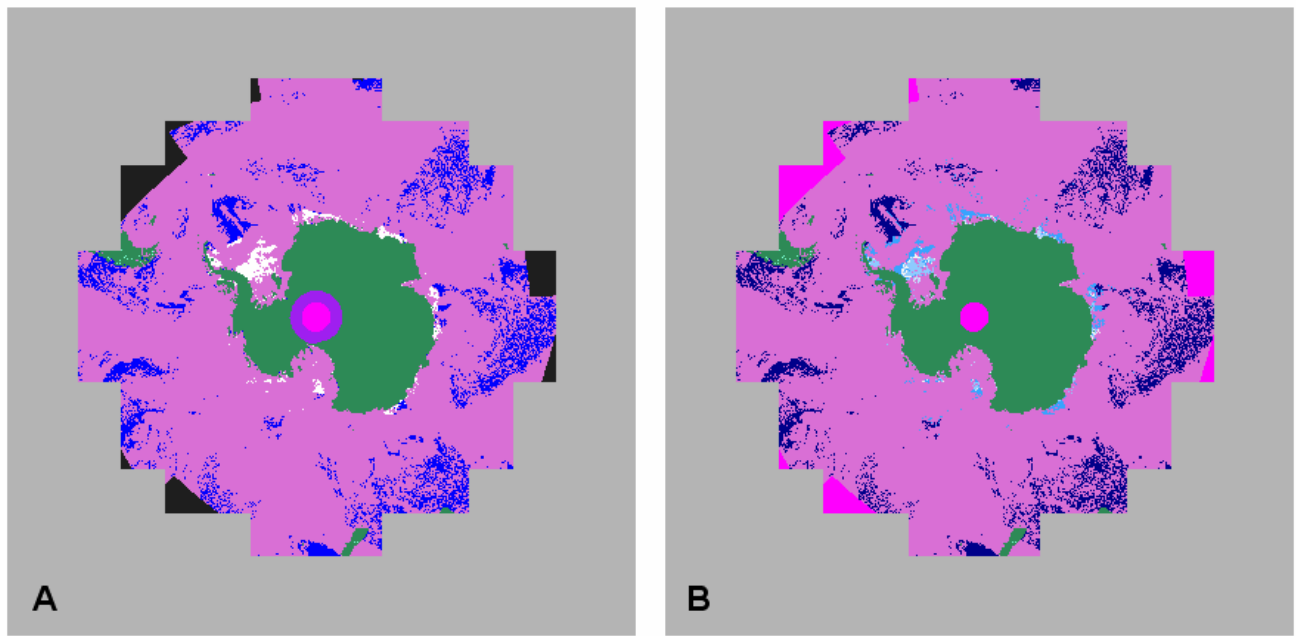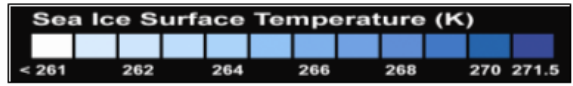| >230 - <250	>250 - <253	>253 - <256	>256 - <259	>259 - <262	>262 - <265	>265 - <268	>268 - <271	>271

Figure 7. MOD29E1D of 20 March 2000 maps of sea ice by reflectance (A) and IST (B) for the Southern Hemisphere.

Key
SEA ICE
OPEN OCEAN
CLOUD
LAND
INLAND WATER
NO DATA
NIGHT
MISSING DATA
NO DECISION
NON-PRODUCTION MASK
FILLED

Sea Ice Surface Temperature (K)
< 261   262   264   266   268   270 271.5

References

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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.

Related Web Sites

EOS
Terra Website **http://terra.nasa.gov**
Aqua Website **http://aqua.nasa.gov**
ECS **http://ecsinfo.gsfc.nasa.gov**
National Snow and Ice Data Center **http://nsidc.org**

MODIS
MODIS Snow/Ice Global Mapping Project **http://modis-snow-ice.gsfc.nasa.gov**
MODIS Project **http://modis.gsfc.nasa.gov**
MODIS Land Discipline **http://modis-land.gsfc.nasa.gov**
Cloud Mask (MOD35) **http://cimss.ssec.wisc.edu/modis1/pdf/CMUSERSGUIDE.PDF**
MODIS Characterization Support Team **http://www.mcst.ssai.biz/mcstweb**
MODIS Atmosphere Discipline **http://modis-atmos.gsfc.nasa.gov**
MODAPS Services **http://modaps.nascom.nasa.gov/services**

HDF-EOS Information and Tools
EOSDIS **http://spsosun.gsfc.nasa.gov/ESDIShome.html**
HDF **http://www.hdfgroup.org**
HDF-EOS **http://hdfeos.gsfc.nasa.gov**
    Note: Samples of HDF-EOS files can be obtained from this site.
ECS Data Handling System **http://edhs1.gsfc.nasa.gov**
MODIS Data Support **http://daac.gsfc.nasa.gov/MODIS/software.shtml**
HEG Tool, HDF-EOS to GIS format conversion tool
 http://eosweb.larc.nasa.gov/PRODOCS/misr/tools/geotiff_tool.html

Earth Science
GSFC Earth Sciences Portal **http://earthsciencesportal.gsfc.nasa.gov**