Appendix. 3-3

AMSR-E Level 2 Map format description (NDX-000273D)

NDX-000273D

AMSR-E Level 2 Map
Product Format Description Document

Japan Aerospace Exploration Agency (JAXA)

Contents

1. Introduction

1.1. Purpose

This document describes the format of AMSR-E level 2Map product which is produced at Earth Observation Center (EOC) of Japan Aerospace Exploration Agency (JAXA). This format specification describes the structure and contents of AMSR-E level2Map product.

1.2. Scope

AMSR-E on the EOS Aqua which is planned to solve the mechanism of trend warming on the earth and so on, and it observes various bands of microwave radiation even if it is cloudy or at night. The AMSR-E data is processed at the EOC, and its products will be distributed to users. There are 6 kinds of products shown in Table 1.2-1.

Table 1.2-1 Kinds of AMSR-E product

Product name	Outline
1A	Raw data observed by AMSR-E. It is the product that is processed on level 0 data for radiometric and geometric correction.
1B	Brightness temperature that is transformed from antenna temperature in level 1A by transformation coefficients.
2	Geophysical quantity for water, water vapor (WV), cloud liquid water (CLW), precipitation (AP), sea surface wind speed (SSW), sea surface temperature (SST), sea ice concentration (IC), snow water equivalent (SWE), and soil moisture (SM), are calculated from the level 1B.
3	Average data that is calculated level 1B or level 2 , and projected it on each map by equirectangular and polar stereo graphic.
1B Map	Projected level 1B product on map.
2Map	Projected level 2 product on map.

Level 2Map product is the projected data on the map, which is selected from level 2 by specified parameters. Number of Image in the level 2Map product is 300 pixels × 300 pixels. Its image size is about 10km at the base point of projection. There are the parameters which can be specified, such as how to resample (Nearest neighbor / Bi-linear), how to project (Equirectangular / Mercator / Polar stereo graphic), and base latitude (standard latitude / scene center / specified latitude). Earth model is WGS84. The detail about the parameters of level 2Map product is shown in the document named "AMSR-E Product Specifications（NDX-000184）".

Level 2Map product is processed from level 2 product. It is output in HDF (Hierarchical Data Format). This document describes only an outline of data in level 2Map product and its format.

2. Related and reference documents

2.1. Related Documents

(1)AMSR-E Product Specifications（NDX-000184）

2.2. Reference Documents

(1)「RESEARCH ANNOUNCEMENT Retrieval Algorithm and Related Study Advanced Microwave Scanning Radiometer (GLI / AMSR) on Advanced Earth Observing Satellite-II」(NDX-000098)

(2)ADEOS-II Science Plan (Science Research) (NDX-000114)

(3)ADEOS-II Science Plan (Science Plan) (NDX-000115)

(4)Document of ADEOS-II AMSR Retrieval Algorithm Development (Ver.0.00)（NDX-000156）

(5)AMSR-E/AMSR Level 2Map/3 Software Design (AMSR-HS-I-027B)

(6)ADEOS-II AMSR EORC Common Library Function Description（NDX-00146）

(7)Granule ID Denomination（NCX-000231）

(8)EOS-PM1 AMSR-E Level 1 Product Specifications（NEB-00011A)

(9)AMSR-E L2 Product Specifications （NDX-000272）

(10)AMSR-E L3 Product Specifications （NDX-000274）

(11)EOC Toolkit Revision Requirement(Draft) （AMSR-SA-MS-I-006E）

(12)HDF Reference Manual Ver4.2r1, March 2005

(13)HDF User's Guide Ver4.2r0, December 2003

3. Structure of product

Level 2Map product has projection of level 2 data on a map. Its data is selected from level 2 data by specified parameters. Level2 product contains geophysical quantities, such as water vapor, cloud liquid water, precipitation, sea surface wind speed, sea surface temperature, sea ice concentration, snow water equivalent, and soil moisture, which are calculated from the brightness temperature. Observation point information is also stored in it.

Level 2Map product contains two major parts the header and data. The header part is composed of Coremeta data. Coremeta data describes the information about a product. Its detail is shown in the section 3.1.1. The calculated geophysical quantity data and position data are stored in the data part.

The structure of level 2Map product is shown in Figure 3-1.

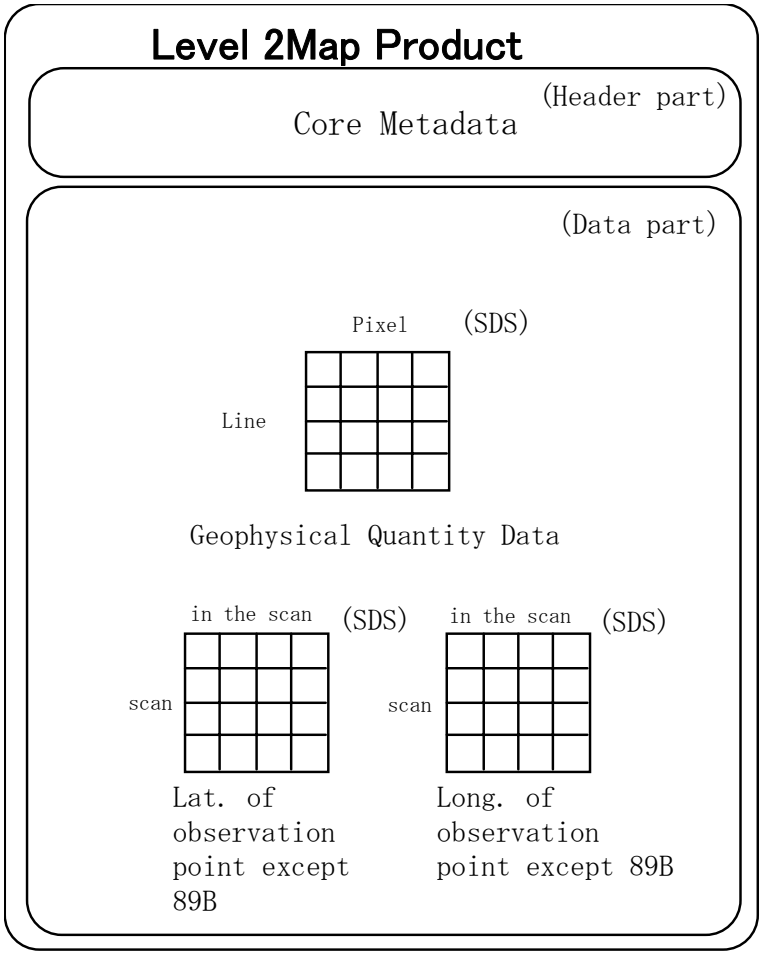


Figure 3-1 Structure of level 2Map product.

3.1. Header part

3.1.1. Coremeta data

Coremeta data contains the necessary information about the product. These items are selected from the necessary attributes listed in the NASA ECS format, revision B.0. NASA ECS retrieves the dataset location with attributes. The meta data is stored in the Coremeta data and its name is considered as global attribute. Metadata in each global attribute is preserved in ASCII.

A list of coremeta data is shown in Table 3.1.1-1. The definitions of the location of the four corners and the scene center are shown in Figure 3.1-1. As shown in the figure, the location of the four corners is the center of each pixel, the location of the scene center is lattice point.

Table 3.1.1-1 List of Coremeta data

Item	Explanation	Example
ShortName	Product name	AMSR-E-L2Map
GeophysicalName	Geophysical quantity name	Water Vapor/Cloud liquid water/Precipitation/Sea surface temperature/Sea surface wind speed/Sea ice concentration/Snow water equivalent/Soil moisture
VersionID	ID of product version	0~255
SizeMBECSDataGranule	Product size (Mbyte)	30(actual)
LocalGranuleID	Number for production management	P1AME020101001A_2MWV0Tak111EC00NWT0000
ProcessingLevelID	ID of processing level	L2Map
ProductionDateTime	Time of production (UT)	2002-1-3-T00:00:00.00Z
RangeBeginningTime	Time to start observing (UT)	00:00:00.00Z
RangeBeginningDate	Date to start observing (UT)	2002-1-3
RangeEndingTime	Time to end observing (UT)	01:00:00.00Z
RangeEndingDate	Date to end observing (UT)	2002-1-3
PGEName	Name of software	(max 20 character)
PGEVersion	Version of software	(max 18 character)
PGEAlgorismDeveloper	Name of algorism developer	(max 20 character)
InputPointer	Input file name	P1AME020101001A_P2WV0Tak111.00
ProcessingCenter	Name of data processing center	JAXA/EOC
ContactOrganizationName	Organization name to contact about this product	JAXA,1401,Ohashi,Hatoyama-machi,Hiki-gun,Saitama,350-0393,JAPAN,+81-49-298-1307,orderdesk@eoc.jaxa.jp
CenterLatitude	Scene center latitude	35.543
CenterLongitude	Scene center longitude	123.456
UpperLeftLatitude	Top left corner latitude	35.543
UpperLeftLongitude	Top left corner longitude	123.456
UpperRightLatitude	Top right corner latitude	35.543
UpperRightLongitude	Top right corner longitude	123.456
LowerLeftLatitude	Bottom left corner latitude	35.543
LowerLeftLongitude	Bottom left corner longitude	123.456
LowerRightLatitude	Bottom right corner latitude	35.543
LowerRightLongitude	Bottom right corner longitude	123.456
StartOrbitNumber	Start orbit number	100
StopOrbitNumber	Stop orbit number	100
OrbitDirection	Orbit direction	DESCENDING
EphemerisGranulePointer	File name for using orbit	EPHEMERIS-1
EphemerisType	Type of using orbit	ELMP,ELMD,GPS
PlatformShortName	Abbreviated name of platform	Aqua
SensorShortName	Abbreviated name of observing sensor	AMSR-E
ECSDataModel	Name of meta data model	B.0
ScienceQualityFlag	Flag when it calculates geophysical quantity	Blank for L1A,L1B,L1BMap
ScienceQualityFlagExplanation	Explanation when it calculate geophysical quantity	Blank for L1A,L1B,L1BMap

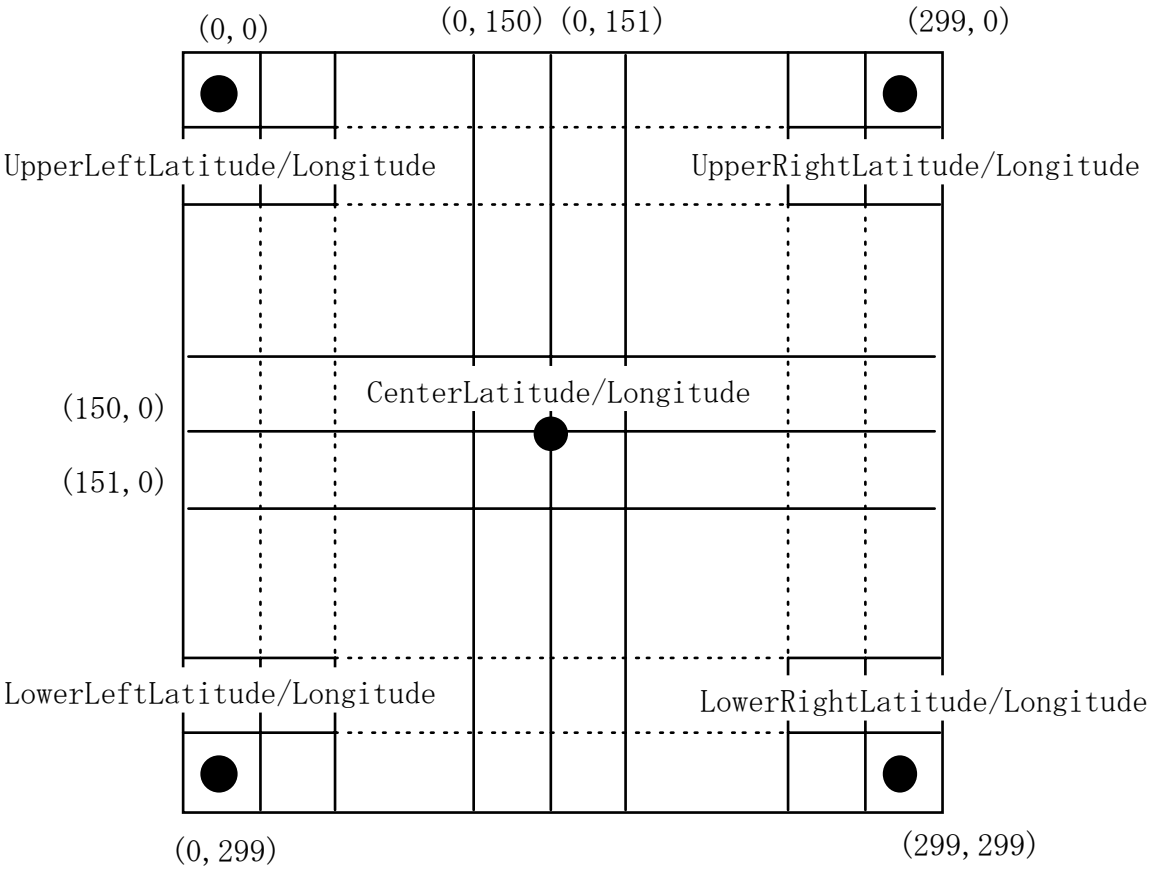


Figure 3.1-1 Definition of location of four corners and scene center

3.2. Data part

Number of image in the level 2Map product is 300 pixels × 300 pixels. Each pixel is 2 bytes. This data is stored as SDS in the product.

The detail of Data part is shown in Table 3.2-1. Its data structures are shown in Figure 3.2-1. The data structure of Geophysical Quantity Data, Lat. of observation point except 89B, and Long. of observation point except 89B are the same.

Table 3.2-1 Data part specifications

No.	Items	Byte	Type	Scale factor	Sample number	Scan number	Unit
1	Geophysical Quantity Data	2	signed int	0.1 0.001 0.1 0.1 0.1 1 0.001 1	300	300	WV:kg/m^2 CLW:kg/m^2 AP:mm/h SSW:m/s SST:℃ IC:% SM:g/cm^3 SWE:mm
2	Lat. of observation point except 89B	2	signed int	0.01	300	300	deg
3	Long. of observation point except 89B	2	signed int	0.01	300	300	deg

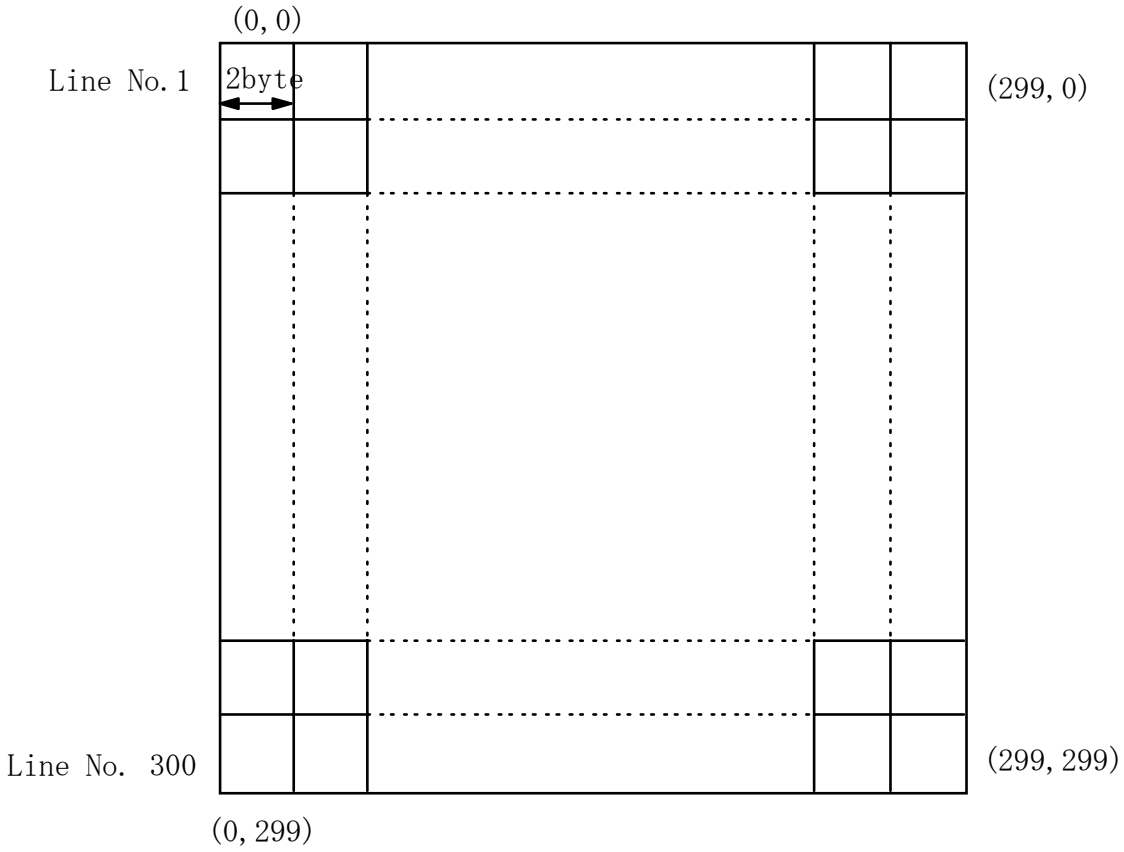


Figure 3.2-1 Structure of Geophysical Quantity Data, Lat. of observation point except 89B, and Long. of observation point except 89B

4. Data size in Product

Data size in level 2Map product is shown in Table 4-1.

Table 4-1 Data size in level 2Map product

Item	No. of Sample	No. of Bytes	Semi Total	Remark
Geophysical Quantity Data	300	2	600	
Lat. of observation point except 89B	300	2	600	
Long. of observation point except 89B	300	2	600	
Total			1800	
Volume/Granule (kB)			527.34	

5. Others

5.1. Local Granule ID

A system of Local Granule ID is shown the following. Details for each item are shown in Table 5.1-1 and Table 5.1-2.

SASENYYMMDDPPPX_XLpppxxxvvvMXnnREVLSnn

Local Granule ID in the case of Water Vapor is shown the followings.

P1AME020101001A_2MWV0Tak111EC00NWT0000

Table 5.1-1 System of Scene ID

Format	Items	Contents
SASENYYMMDDPPPX		
SA	Satellite name	'P1':EOS-PM1
SEN	Kind of sensor	'AME':EOS-PM1 AMSR-E
YYMMDD	Date to start observing	It is expressed A.D.(UT).
PPP	Path number	'001'～'233':
X	Orbit direction	'A': Ascending 'D': Descending

Table 5.1-2 System of Product ID

Format	Items	Contents
XLpppxxxvvvMXnnREVLSnn		
X	Kind of product	'O': Ordered product
L	Processing level	'M': Fixed
ppp	Product code	'WV0': Water Vapor 'CLW': Cloud Liquid Water 'AP0': Amount of Precipitation 'SSW': Sea Surface Wind 'SST': Sea Surface Temperature 'IC0': Ice Concentration 'SM0': Soil Moisture 'SWE': Snow Water Equivalence
xxx	Name of algorism developer	'000': This item is effective only in EORC. If it is used in EOC, it is set '000'. 'Tak': Takeuchi 'Cav': Cavalieri 'Wen': Wentz 'Liu': Liu 'Pet': Petty 'Jac': Jackson 'Shi': Shibata 'Njo': Njoku 'Com': Comiso 'Pal': Paloscia 'Koi': Koike 'Kel': Kelly
vvv	Algorism version	It is expressed 3 characters, 'nnn'. First character, (Major version)（'0'～'9'） Last 2 characters are used as minor version('00'～'99')
M	Kind of projection	'E': Equirectangular 'M': Mercator 'P': Polar stereo graphic
Xnn	Base latitude	'C00': Scene center 'D00': Standard latitude 'Snn': Specified latitude (S90～N90, intervals of 5 degree)
R	Interpolation	'B': Bi-liner 'N': Nearest neighbor
E	Earth model	'W': WGS84
V	Direction for map	'T': True North
L	Total movement along longitude	'0': Fixed
Snn	Center latitude	'S90': South pole 'N90': North pole

5.2. Map projection

There are three projections, such as equrectangular, mercator, and polar stereo graphic. Its explanations are as follows.

5.2.1. Equirectangular

Latitude and longitude (φ, λ) are projected on the (x, y) in the coordinate of equirectangular.

$$x = \lambda$$
$$y = \phi$$

5.2.2. Mercator

Assuming that the origin of the coordinates is (φ_0、λ_0), The formulas which show the relationship between the (φ、λ) and the (x, y) in the coordinate of mercator are as follows.

$$x = R_a \left(\lambda - \lambda_0 \right)$$

$$y = R_a \cdot \ln \left[\tan\left\{ \frac{\pi}{4} + \frac{1}{2} \left(\phi - \phi_0 \right) \right\} \cdot \left\{ \frac{1 - e \cdot \sin\left(\phi - \phi_0 \right)}{1 + e \cdot \sin\left(\phi - \phi_0 \right)} \right\}^{\frac{e}{2}} \right]$$

The R_a shows the semi-major axis of the ellipsoid and the e for flattening. The e, flattening, is as follows.

$$e = \sqrt{1 - \frac{R_b^2}{R_a^2}}$$

5.2.3. Polar stereo graphic

Assuming that the coordinate of polar stereo graphic can be shown as the (X, Y) and latitude and longitude is the (φ, λ), the relationship of each other is as follows.

（1）Calculating latitude based on the center of the earth.

Latitude based on the center of the earth, φ', is as follows.

$$\phi' = \tan^{-1}\left\{\left(1-e^2\right)\tan\phi\right\}$$

（2）Calculating the position in the coordinate of polar stereo graphic

The position in the coordinate of polar stereo graphic can be calculated by the next formulas. There are two cases in the northern hemisphere and the southern.

1）Northern hemisphere

$$\frac{X}{m_0} = -2R_e\frac{\sqrt{1-e^2}\cos\phi'}{\sqrt{\left(1-e^2\right)\cos^2\phi'}+\sin\phi'}\sin\left(-\lambda\right)$$

$$\frac{Y}{m_0} = -2R_e\frac{\sqrt{1-e^2}\cos\phi'}{\sqrt{\left(1-e^2\right)\cos^2\phi'}+\sin\phi'}\cos\left(-\lambda\right)$$

2）Southern hemisphere

$$\frac{X}{m_0} = 2R_e\frac{\sqrt{1-e^2}\cos\phi'}{\sqrt{\left(1-e^2\right)\cos^2\phi'}+\sin\phi'}\sin\lambda$$

$$\frac{Y}{m_0} = 2R_e\frac{\sqrt{1-e^2}\cos\phi'}{\sqrt{\left(1-e^2\right)\cos^2\phi'}+\sin\phi'}\cos\lambda$$

R_e, e and m_0 are as follows.

R_e : Semi-major axis of the ellipsoid

e : Flattening 1 - f_2

m_0 : Scale on the origin （1.0）

The definition of coordinates is shown in Fig. 5.2-1 and Fig. 5.2-2. In the case of the Northern Hemisphere, a projection coordinates top is defined as the 90 west longitude, and coordinates are set up so that it may become the 180 west longitude, the 90 east longitudes, and the zero east longitude from

there at a clockwise rotation. In the case of the Southern Hemisphere, a projection coordinates top is defined as the 90 west longitude, and coordinates are set up so that it may become the zero east longitude, the 90 east longitudes, and the 180 west longitude from there at a clockwise rotation.

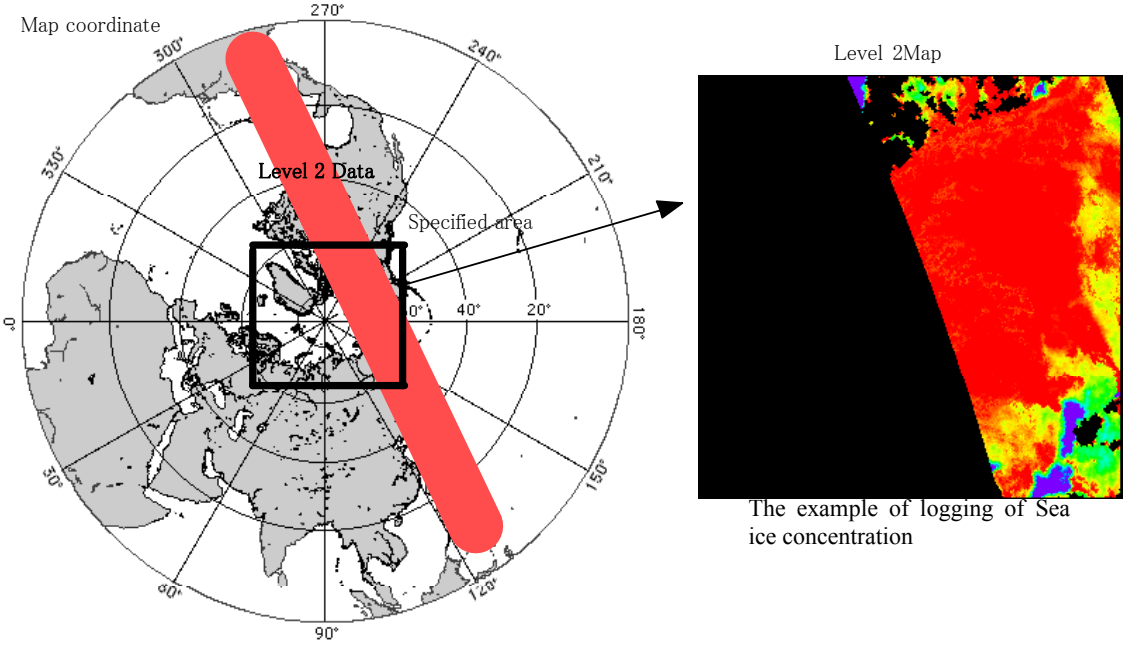


Figure 5.2-1 Direction of map projection（Northern hemisphere）

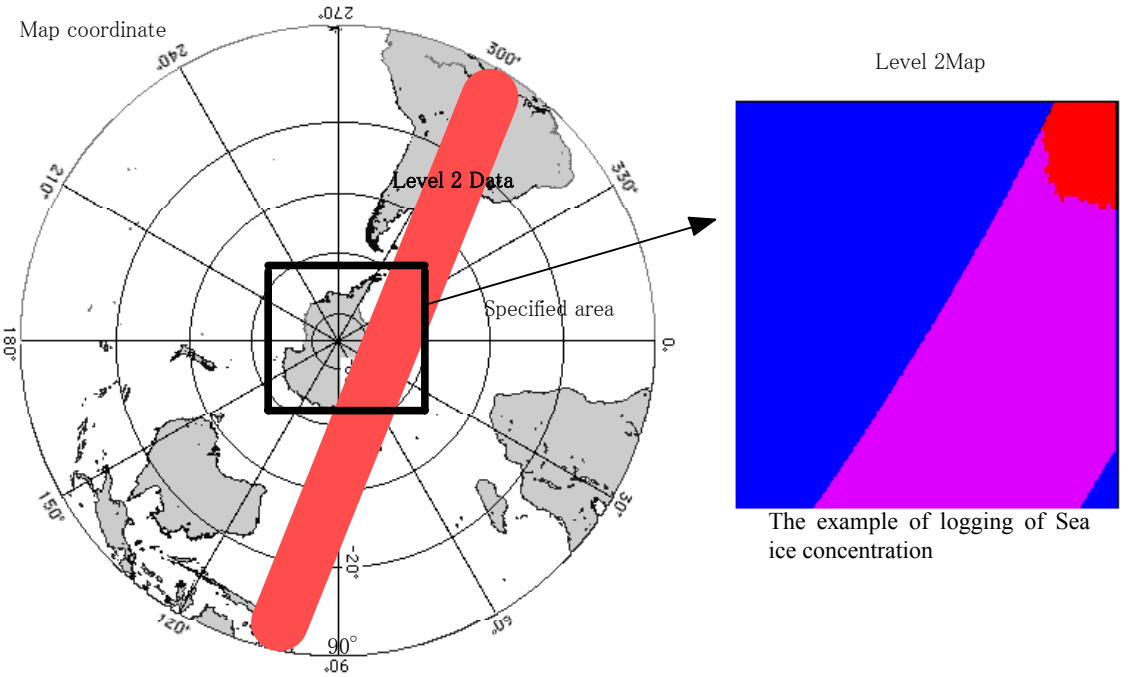


Figure 5.2-2 Direction of map projection（Southern hemisphere）

5.3. Interpolation

The data in level 2Map product is interpolated for making image. There are two methods of

interpolation, such as Nearest neighbor and Bi-linear. Explanation for its interpolation is as follows. How to interpolate is shown in Figure 5.3-1.

5.3.1. Nearest neighbor

Interpolated value is the point which is the nearest observation point. Its formula is as follows.

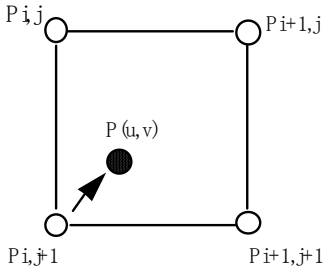
$$P = P_{ij}$$
$$i = [\, u + 0.5 \,]$$
$$j = [\, v + 0.5 \,]$$

[ ] is the Gaussian symbol. It expresses the max integer value below its value.

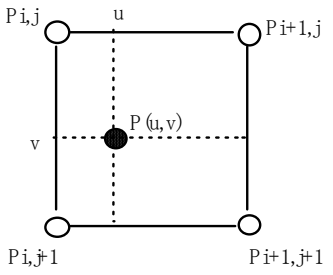
5.3.2. Bi-linear

Interpolated value is calculated from four points which are near the observation point. Its formula is as follows.

$$P = \{(i+1) - u\}\{(j+1) - v\}P_{i,j} + \{(i+1) - u\}(v - j)P_{i,j+1} + (u - i)\{(j+1) - v\}P_{i+1,j} + (u - i)(v - j)P_{i+1,j+1}$$



Nearest neighbor



Bi-linear

: Calculated point

: Observation point

Figure 5.3-1 How to interpolate

5.4. Dummy data

The dummy data (data other than the amount of geophysics) in level 2Map is as follows.

* -9999 : When there is no geophysical data within observation swath
  This value is set up when computing neither the case where the amount of geophysics is incomputable (a packet loss, the abnormalities in brightness temperature of level 1B, the amount calculation error of geophysics, etc.) , nor the amount of geophysics (This case is based on conditions peculiar to the amount of physics. For example, in the case of the amount of geophysics for marine [, such as SST,], the area of land does not compute the amount of geophysics.).
* -8888 : The area besides observation swath

The example of a picture image of Sea ice concentration level 2Map is shown in Figure 5.4-1.

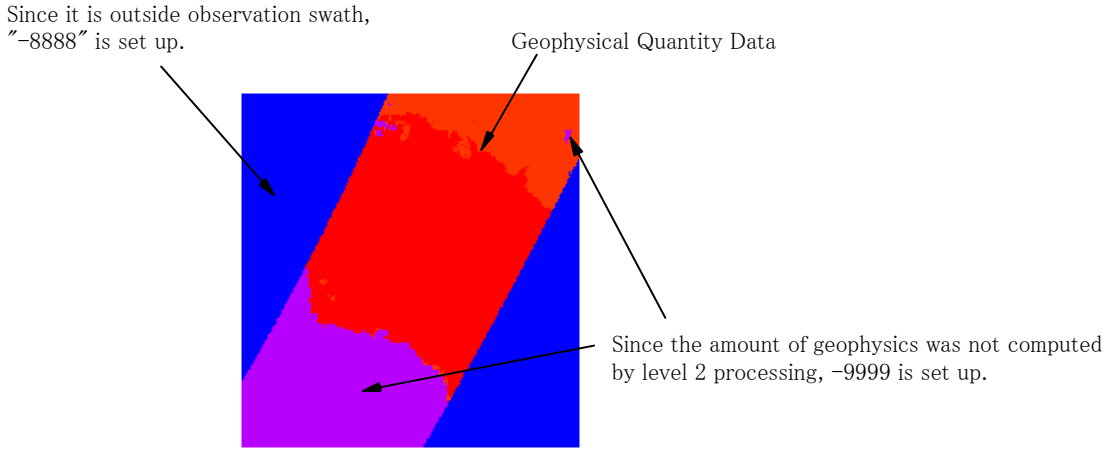


Figure 5.4-1 The example of a picture image of Sea ice concentration level 2Map

6. Explanation about data

Explanation for each data is shown in next section. Each item in its explanation is described the followings.

HDF_MODEL：HDF model to put each data in the file. In the case of standard product, the data has "scientific data sets", "Vdata" and "global attribute". Most of data elements are set as scientific data sets in it.

ARRAY_DIMENSION：Data size of each dimension if data type is array dimension(in the case of nominal).

STORAGE_TYPE：Type of data element. There are "int 8", "int16", "int32", "unsigned integer8","unsigned integer32", "float32", "float64".

NUMBER_OF_BYTE：Number of byte to preserve the data element.

UNIT：Data unit. For example, there are "deg", "count2", ”Kelvin”, and so on.

MINIMUM_VALUE：Minimum value of data element.

MAXIMUM_VALUE：Maximum value of data element.

SCALE_FACTOR：Standard product has some elements which is changed float into integer for interchangeable among the machines and preserved(for example, geophysical quantity etc.). That's why it is necessary to multiply the stored data by scale_factor for use. The scale_factor is used when the data, which is changed float into integer is put it back.
（For example, when the sea surface temperature is 18.36℃, it is stored as 1836 and scale_factor becomes 0.01.）

6.1. Explanation for each data

Explanations for each data are as follows.

（１）Geophysical Quantity Data

HDF_MODEL : SDS
ARRAY_DIMENSION :300×300
STORAGE_TYPE : Signed int 16
NUMBER_OF_BYTE : 2
UNIT : kg/m^2 (WV,CLW) / mm (SWE) / mm/h (AP) / m/s (SSW) / ℃ (SST) / % (IC)
g/cm^3 (SM)
MINIMUM_VALUE : 0 (WV) / 0 (CLW) / 0 (AP) / 0 (SSW) / -2 (SST) / 0 (IC) / 0 (SM)
0 (SWE)
MAXIMUM_VALUE : 70 (WV) / 1.0 (CLW) / 100 (AP) / 30 (SSW) / 35 (SST) / 100 (IC)
TBD (SM) / 10000 (SWE)
SCALE_FACTOR : 0.1 (WV) / 0.001 (CLW) / 0.1 (AP) / 0.1 (SSW) / 0.1 (SST) / 1 (IC)
0.001 (SM) / 1 (SWE)

（２）Lat. of observation point except 89B

Latitude of observation points corresponding to Geophysical Quantity Data explained above is stored. North latitude is expressed as 0 to 90 degrees, while south latitude is expressed as -90 to 0 degrees.

HDF_MODEL : SDS

ARRAY_DIMENSION : 300×300
STORAGE_TYPE : signed int 16
NUMBER_OF_BYTE : 2
UNIT : deg
MINIMUM_VALUE : -90
MAXIMUM_VALUE : 90
SCALE_FACTOR : 0.01

（３）Long. of observation point except 89B

Longitude of observation points corresponding to Geophysical Quantity Data explained above is stored. East longitude is expressed as 0 to 180 degrees, while west longitude is express as -180 to 0 degrees.

HDF_MODEL : SDS
ARRAY_DIMENSION : 300×300
STORAGE_TYPE : signed int 16
NUMBER_OF_BYTE : 2
UNIT : deg
MINIMUM_VALUE : -180
MAXIMUM_VALUE : 180
SCALE_FACTOR : 0.01

7. Abbreviation

Abbreviation	Formula name
ADA	Antenna Drive Assembly
ADA ROT	Antenna Drive Assembly Rotor
ADE	Antenna Drive Electronics
AP	Amount of Precipitation
CLW	Cloud Liquid Water
CSM	Cold Sky Mirror
HTS	Hot Temperature Noise Source
IC	Ice Concentration
LNA	Low Noise Amplifier
MREF	Main Reflector
MWA	Momentum Wheel Assembly
PDUC	Power Distributor Unit Control Unit
PDUS	Power Distributor Unit Sensor Unit
RX	Receiver
SM	Soil Moisture
SPC	Signal Processor Control Unit
STR	Structure
SPS	Signal Processor Sensor Unit
SST	Sea Surface Temperature
SSW	Sea Surface Wind Speed
SWE	Snow Water Equivalence
TCC	Thermal Controller Control Unit
TCS	Thermal Controller Sensor Unit
WV	Water Vapor