ALOS-4 PALSAR-3
Standard Product Format Description

(GeoTIFF format)

Jul. 2024, Rev. NC

Japan Aerospace Exploration Agency

Revision History

Rev.	Month/Year	Comments	Remarks
NC	Jul. 2024	—	

ALOS-4 PALSAR-3 Standard Product Format Description (GeoTIFF)

1. Overview

This document describes the format specifications for ALOS-4 PALSAR-3 GeoTIFF Level 1.5/2.1 products which are generated by JAXA.

The overall structure of the GeoTIFF product is shown in Table 1-1.

Table 1-1 Overall structure of the GeoTIFF product

Item	Description	Observation mode	Processing level	Reference
GeoTIFF file	Tiff image file with geographic information	All modes	L1.5, 2.1	Chapter 2, 3
Summary information	Text file that contains observation and processing information	All modes	L1.5, 2.1	Chapter 4
Thumbnail image	Image file reduced in size by thinning out the original image	All modes	L1.5, 2.1	Chapter 5
RPC	Text file that contains coefficients for converting latitude, longitude, and altitude into pixels and lines	All modes	L1.5	Chapter 6

1.1.Related Documents

The related documents are listed in Table 1-2.

Table 1-2 Reference documents

No.	Title of the documents
[1]	ALOS-4 PALSAR-3 Standard Product Definition
[2]	ALOS-4 PALSAR-3 Standard Product Format Description (CEOS)
[3]	ALOS-4 PALSAR-3 Standard Product Format Description (GeoTIFF) [This document]

2. Specification of GeoTIFF Products

2.1. Outline of GeoTIFF Standard

GeoTIFF is a metadata standard, which allows geometric information to be embedded within Aldus-Adobe's raster Tagged Image File Format (TIFF) file.

ALOS-4 PALSAR-3 GeoTIFF products can be created for the processing levels 1.5 and 2.1.

The GeoTIFF files are created for each polarization. Table 2-1 shows the number of GeoTIFF files for each polarization mode.

Table 2-1 Number of files for each polarization mode

Polarization mode	Single	Dual	Full
GeoTIFF files	1	2	4

2.2. File Name

The filename definitions of GeoTIFF product is shown in Table 2-2.

Table 2-2 Filename definition of GeoTIFF file

File type	Filename	File description
GeoTIFF	IMG-[Polarization]-[Scene ID]-[Product ID].tif	GeoTIFF format file that contains each integer pixel value and the location and map projection information in the header section

Please see the reference document [1] for the scene ID and product ID of the filename in Table 2-2. The naming convention for polarization information are shown in Table 2-3.

Table 2-3 Naming rule of polarization information

Itrem	Symbols	Rules
Polarization = XX	XX	"HH": Horizontally polarized wave transmission / Horizontally polarized wave receiving "HV": Horizontally polarized wave transmission / Vertically polarized wave receiving "VH": Vertically polarized wave transmission / Horizontally polarized wave receiving "VV": Vertically polarized wave transmission / Vertically polarized wave receiving

3. Format

3.1. GeoTIFF File

GeoTIFF is a metadata standard which allows geometric information to be embedded within a TIFF image file. In ALOS-2 GeoTIFF products, GeoTIFF files are generated in TIFF-Strip format, and some GeoTIFF-tags (identifiers) are different in each processing level. All TIFF files and GeoTIFF-tags are based on TIFF Revision 6.0 and GeoTIFF Revision 1.0 standard, and image data is recorded in little endian.

Since TIFF format supports 4 GB image size in maximum, the image which exceeds 4 GB is stored in BigTIFF format.

3.1.1. TIFF Tags

TIFF tags common to all processing levels are shown in Table 3-1.

Table 3-1 Common TIFF-tags in All Processing Levels (1/3)

Tag name	Tag type	Description	Remark
ImageWidth	SHORT or LONG	Number of pixels in one line	
ImageLength	SHORT or LONG	Number of lines	
BitsPerSample	SHORT	Number of bits in one sample L1.5 = 16 (fixed value) L2.1 = 16 (fixed value)	L1.5: 16bit (absolute value) L2.1: 16bit (absolute value)
Compression	SHORT	Compression type = 1 (fixed value)	1 = No compression 2 = ITU-T modified Huffman RLE 3 = ITU-T Group 3 fax encoding 4 = ITU-T Group 4 fax encoding 5 = LZW (fixed-length) compression 6 = JPEG compression (old style) 7 = JPEG compression (new style) 8 = ZIP compression 32773 = Packbits compression
PhotometricInterpretation	SHORT	Color space type of bitmap image data = 1 (fixed value)	0 = WhiteIsZero (Pixel value: White=0, Black =(2^BitsPerSample-1)) 1 = BlackIsZero (Pixel value: Black=0, White=(2^BitsPerSample-1)) 2 = RGB direct color (min=0 as black, max=(2^BitsPerSample-1) as white) 3 = Palette color (min=0, max=(2^BitsPerSample-1)) 4 = Transparency Mask (definition of masked region)

Table 3-1 Common TIFF-tags in All Processing Levels (2/3)

Tag name	Tag type	Description	Remark
StripOffsets	SHORT or LONG	The byte offset of each strip	
RowsPerStrip	SHORT or LONG	Number of rows in each strip = 1 (fixed value)	
StripByteCounts	SHORT or LONG	Number of bytes in each strip	
ImageDescription	ASCII	Transit and receive polarization information = 'HH', 'HV', 'VH', 'VV'	Transmit, receive order
Orientation	SHORT	Orientation of image = 1 (fixed value)	1 = row: Top to Bottom, column: Left to Right 2 = row: Top to Bottom, column: Right to Left 3 = row: Bottom to Top, column: Right to Left 4 = row: Bottom to Top, column: Left to Right 5 = row: Left to Right, column: Top to Bottom 6 = row: Right to Left, column: Top to Bottom 7 = row: Right to Left, column: Bottom to Top 8 = row: Left to Right, column: Bottom to Top
SamplesPerPixel	SHORT	Number of samples in one pixel L1.5 = 1 (fixed value) L2.1 = 1 (fixed value)	L1.5: 1 (absolute value) L2.1: 1 (absolute value)
PlanarConfiguration	SHORT	Storing order of the data = 1 (fixed value)	1 = Chunky format: The component values for each pixel are stored contiguously 2 = Planar format: The components are stored in separate components. L1.5: MMM… L2.1: MMM…

Table 3-1 Common TIFF-tags in All Processing Levels (3/3)

Tag name	Tag type	Description	Remark
Software	ASCII	Software name and version = 'JAXA L1 SoftWare NNN.NNN'	NNN.NNN: version number
DateTime	ASCII	Product generation time (UTC) = 'YYYY:MM:DD HH:MM:SS'	
SampleFormat	Array of SHORT	Type of data L1.5 = 1 (fixed value) L2.1 = 1 (fixed value)	1 = unsigned integer 2 = signed integer 3 = float 4 = undefined 5 = complex integer 6 = complex float The number of elements of the array is equal to the value of "SamplePerPixel" tag
A4CalibrationFactor	DOUBLE	Calibration facto (CF)	This tag is a private tag. Tag number: 32769 See Section 3.2 for usage instructions.

3.1.2. GeoTIFF Tag of Level 1.5/2.1 Products

GeoTIFF tags of Level 1.5/2.1 products are shown in Table 3-2.

Table 3-2 GeoTIFF-tags of Level 1.5 and Level 2.1 Products (1/4)

Tag name	Tag type	Description	Remark
GTCitationGeoKey	ASCII	Processing option Geo-coded = 'Geo-coded' Geo-reference = 'Geo-reference'	
GeogLinearUnitsGeoKey	SHORT	Coordinates unit (length) = 9001 (fixed value)	9001 = Linear_Meter[m]
GeogAngularUnitsGeoKey	SHORT	Coordinates unit (angle) = 9102 (fixed value)	9102 = Angular_Degree[deg]
ProjLinearUnitsGeoKey	SHORT	Projection coordinates unit (length) = 9001 (fixed value)	9001 = Linear_Meter[m]
GeogPrimeMeridianGeoKey	SHORT	The position of the standard meridian line = 8901 (fixed value)	8901 = PM_Greenwich (Greenwich meridian)
ModelPixelScaleTag	DOUBLE	The size of a pixel = (pixel width, line width, 0.0)	Units of width are as same as “GeogLinearUnitsGeoKey” and “ProjLinearUnitsGeoKey”. [m] When GTCitationGeoKey is 'Geo-coded': set this tag. When GTCitationGeoKey is 'Geo-reference': Do not set this tag (= delete the tag).
ModelTiepointTag	DOUBLE	Correspondence of pixel-line coordinates and map coordinates. (Pixel no., Line no, 0.0, Map-addr. X, Map-addr. Y, 0.0) =(0.5, 0.5, 0.0, Map-addr. X, Map-addr. Y, 0.0)	When GTCitationGeoKey is 'Geo-coded': set this tag. When GTCitationGeoKey is 'Geo-reference': Do not set this tag (= delete the tag).
ModelTransformationTag	DOUBLE	The conversion matrix from a pixel and line coordinates to map coordinates = (a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p) In a two-dimensional coordinate plane, $\begin{vmatrix} \text{Map address X} \\ \text{Map address Y} \\ 0 \\ 1 \end{vmatrix} = \begin{vmatrix} a & b & 0 & d \\ e & f & 0 & h \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} \begin{vmatrix} \text{Pixel no.} \\ \text{Line no.} \\ 0 \\ 1 \end{vmatrix}$ = (a, b, 0, d, e, f, 0, g, 0, 0, 0, 0, 0, 0, 0, 1)	When (pixel no., line no.) = (P, L); Map address X = a * P + b * L + d Map address Y = e * P + f * L + h When GTCitationGeoKey is 'Geo-coded': set this tag. When GTCitationGeoKey is 'Geo-reference': Do not set this tag (= delete the tag).

Table 3-2 GeoTIFF-tags of Level 1.5 and Level 2.1 Products (2/4)

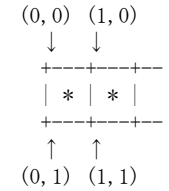
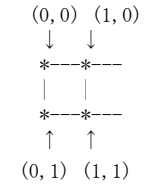
Tag name	Tag type	Description	Remark
GTModelTypeGeoKey	SHORT	Coordinate system type = 1 (fixed value)	1 = ModelTypeProjected (Projection Coordinate System) 2 = ModelTypeGeographic (Geographic Latitude-Longitude System) 3 = ModelTypeGeocentric (Geocentric (X,Y,Z) Coordinate System)
GTRasterTypeGeoKey	SHORT	Alignment of pixel value = 1 (fixed value)	1 = PixelIsArea The first pixel applies the domain surrounded by (0, 0), (0, 1), (1, 0), and (1, 1). The center of pixel is located in (0.5, 0.5).  2 = PixelIsPoint The first pixel applies the domain surrounded by (-0.5,-0.5), (0.5,-0.5), (-0.5, 0.5), (0.5, 0.5). The center of pixel is located in (0, 0). 
GeogGeodeticDatumGeoKey	SHORT	Geographic coordinate system = 6655(fixed value)	6655 = The International Terrestrial Reference Frame 1997(ITRF97)
GeogEllipsoidGeoKey	SHORT	Ellipsoid code = 7019 (fixed value)	7019 = Ellipse_GRS_1980(GRS80)
ProjectedCSTypeGeoKey	SHORT	Map projection code User defined = 32767 (fixed value)	In all the projection system, the value “User defined” is set

Table 3-2 GeoTIFF-tags of Level 1.5 and Level 2.1 Products (3/4)

Tag name	Tag type	Description	Remark
ProjectionGeoKey	SHORT	Map projection code UTM projection Northern Hemisphere = 16000 + Zone no. Southern Hemisphere = 16100 + Zone no. PS / MER / LCC projection User defined = 32767 (fixed value)	In a case of other than UTM, the value “User defined” is set.
GeographicTypeGeoKey	SHORT	Map coordinate code = 4338 (fixed value)	4338 = ITRF97
GeogCitationGeoKey	ASCII	Specify a geographic coordinate system, an ellipsoid model, and a map projection system. = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=UTM' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=PS' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=MER' = 'Datum=ITRF97 Ellipsoid=GRS80 Projection=LCC'	
The following tag is specified only when “ProjectionGeoKey” is set as “user defined” (32767)			
ProjCoordTransGeoKey	SHORT	Map projection code PS projection = 15 (fixed value) MER projection = 7 (fixed value) LCC projection = 8 (fixed value)	PS projection 15 = CT_PolarStereographic MER projection 7 = CT_Mercator LCC projection 8 = CT_LambertConfConic_2SP
On the following tags, only the parameter needed in the selected map projection is specified.			
ProjNatOriginLongGeoKey	DOUBLE	Longitude of the map-projection natural origin In UTM and PS projection: Center longitude of projection is specified In MER and LCC The longitude of the map starting point is specified.	The unit specified in “GeogAngularUnitsGeoKey” is [deg]. The natural origin of northern hemisphere corresponds to negative value of map coordinate y, and that of southern hemisphere, positive value, in the case of PS projection.
ProjNatOriginLatGeoKey	DOUBLE	Latitude of the map-projection natural origin In UTM and PS projection: The center latitude of projection is specified In MER and LCC The latitude of the map starting point is specified.	The unit specified in “GeogAngularUnitsGeoKey” is [deg].

Table 3-2 GeoTIFF-tags of Level 1.5 and Level 2.1 Products (4/4)

Tag name	Tag type	Description	Remark
On the following tags, only the parameter needed in the selected map projection is specified.			
ProjFalseEastingGeoKey	DOUBLE	The easting value from the map-projection natural origin (to determine the map natural origin). It is specified only in the case of UTM projection. = 500000.0 (fixed value)	The unit specified in “ProjLinearUnitsGeoKey” is used [m]
ProjFalseNorthingGeoKey	DOUBLE	The northing value from the map-projection natural origin (to determine the map natural origin). It is specified only in the case of UTM projection. Northern Hemisphere = 0 (fixed value) Southern Hemisphere = 10000000.0 (fixed value)	The unit specified in “ProjLinearUnitsGeoKey” is used [m]
ProjStdParallel1GeoKey	DOUBLE	Latitude of primary standard parallel. It is specified only in the case of LCC projection	The unit specified in “GeogAngularUnitsGeoKey” is used [deg]
ProjStdParallel2GeoKey	DOUBLE	Latitude of second standard parallel. It is specified only in the case of LCC projection	The unit specified in “GeogAngularUnitsGeoKey” is used [deg]
ProjScaleAtNatOriginGeoKey	DOUBLE	Scale factor at natural origin It is specified only in the cases of UTM and PS projection. UTM = 0.9996 (fixed value) PS = 1.0 (fixed value)	no-dimension

3.2. Conversion to Real Value

The conversion method from the integer value of each pixel in a GeoTIFF file to a real value (Sigma Naught: σ_0) is shown below:

$$\sigma_0 = 10 * \log_{10} < DN^2 > + \mathrm{CF}$$

Here, DN is a pixel value of level 1.5 or level 2.1 product. CF is a calibration factor recorded in "A4CalibrationFactor" tag (see Table 3.1) and "Calibration factor (CF)" in the summary information.

4. Summary Information

The format of the summary information of the GeoTIFF product is the same as that of the CEOS product. For details, please refer to the following document.

Reference document [2], 5. Summary Information

5. Thumbnail Image

The format of the thumbnail image of the GeoTIFF product is the same as that of the CEOS product. For details, please refer to the following document.

Reference document [2], 6. Thumbnail Image

6. RPC

The format of the RPC of the GeoTIFF product is the same as that of the CEOS product. For details, please refer to the following document.

Reference document [2], 7. RPC