Global 25 m Resolution PALSAR-2/PALSAR Mosaic

(Ver.2.4.0)

Dataset Description

Japan Aerospace Exploration Agency (JAXA)

Earth Observation Research Center (EORC)

Revision history

Version	Release Date	Revised Content
Ver.2.0.0	Apr. 11, 2022	-
Ver.2.1.0	Jun. 20, 2022	Revised the Appendix. Revised Table 3.1 (Number of tiles) Revised a description of each section.
Ver.2.1.1	Jul. 21, 2022	Revised the Appendix.
Ver.2.1.2	Sep. 13, 2022	Revised the Appendix.
Ver.2.2.0	Apr. 28, 2023	Revised Table 3.1 (Number of tiles and Original SAR data). Changed CARD4L to CEOS-ARD (Sections 1, 3 and 4). Revised Table 4.1 (File name). Revised Table 5.1 (processing mask information). Revised the Appendix.
Ver.2.3.0	May 31, 2023	Revised a description about PALSAR of each section. Revised the Appendix. Revised Table 3.1 (Number of tiles).
	Aug. 09, 2023	Revised the Appendix. Revised Table 3.1 (Number of tiles).
Ver.2.4.0	May 17, 2024	Changed CEOS-ARD NRB to Combined CEOS-ARD for Synthetic Aperture Radar (Sections 1, 3 and 4). Revised the Appendix. Revised Table 3.1 (Number of tiles).

Table of Contents

1 Overview of the dataset

This dataset description refers to global 25 m resolution ALOS-2 PALSAR-2/PALSAR mosaic datasets (hereinafter referred to as “PALSAR-2/PALSAR global mosaics”) **Version 2,** released by JAXA.

The PALSAR-2/PALSAR global mosaics are free and open annual datasets generated by JAXA using the L-band Synthetic Aperture Radar (PALSAR-2 and PALSAR) on the Advanced Land Observing Satellite-2 (ALOS-2) and Advanced Land Observing Satellite (ALOS). The mosaics have been created by assembling long paths of PALSAR-2/PALSAR backscatter images observed through the ALOS-2 / ALOS global Basic Observation Scenario. Correction of geometric distortions (ortho-rectification) and topographic effects on image intensity (radiometric slope correction) have been applied.

The datasets are available in HH and HV polarizations, given as linear amplitude Gamma-0 backscatter. They are provided as 1x1 degree tiles in geographical (lat/long) coordinates with a pixel spacing of 0.8 arc seconds (approx. 25 m at the Equator).

The version 2 PALSAR-2/PALSAR global mosaics fully replace all earlier (version 1) PALSAR-2/PALSAR mosaic releases. The version 2 products have significantly improved geolocation accuracy and refined radiometric balancing between adjacent paths, and users still utilizing version 1 PALSAR-2/PALSAR datasets are advised to substitute those with the Ver.2 datasets.

Key characteristics of the Version 2 processing methods and output formats include:

- GDAL based mosaicking process to improve absolute geometric accuracy and processing speed.
- AW3D30 Digital Elevation Model used.
- Products developed to comply with Combined CEOS Analysis Ready Data (CEOS-ARD) for Synthetic Aperture Radar Product Family Specification (PFS).
- Only data from the target year have been used for each annual mosaic, and hence no gap-filling using data from previous years in case of gaps in the annual global coverage.
- Radiometric balancing between adjacent paths is applied to land data only.

Further descriptions of the above issues are provided in section 6.

Information for newly released versions will be added to the appendix.

2 Mosaic processing algorithm

The algorithm for radiometric balancing between adjacent paths derives the gain correction function from the overlapping region in the far and near range. A simplified concept is shown in Figure 2.1. Detailed information is described in Shimada et al. (2011) listed in section 9.

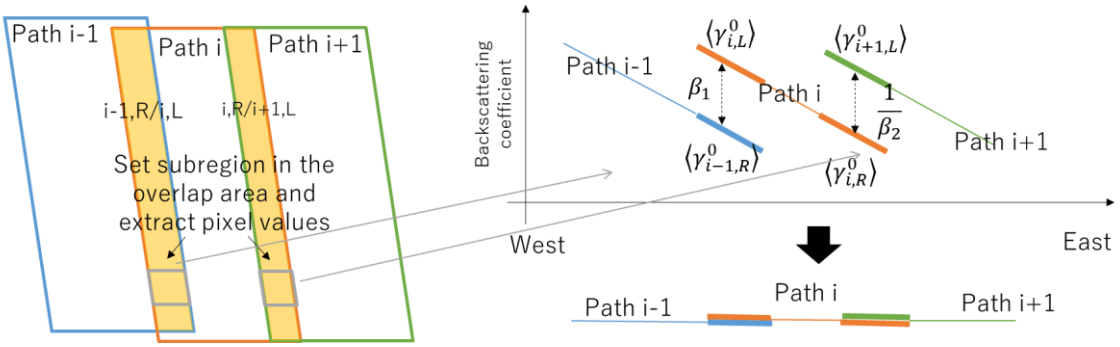

Figure 2.1 A simplified concept of radiometric balancing between adjacent paths.

Gain for path *i* in the overlap (β_1 for the left side and $1/\beta_2$ for the right side) is determined as

$$\beta_1 = \sqrt{\langle\gamma^0_{i-1,R}\rangle / \langle\gamma^0_{i,L}\rangle} \qquad (1)$$

$$\frac{1}{\beta_2} = \frac{1}{\sqrt{\langle\gamma^0_{i,R}\rangle / \langle\gamma^0_{i+1,L}\rangle}} \qquad (2)$$

Where $\langle\gamma^0_{i-1,R}\rangle$, $\langle\gamma^0_{i,L}\rangle$, $\langle\gamma^0_{i,R}\rangle$ and $\langle\gamma^0_{i+1,L}\rangle$ is the averaged backscattering coefficient within the subregion of overlap area of path *i-1*, left side of path *i,* right side of path *i* and path *i+1,* respectively. The sub-pixel gain from β_1 and $1/\beta_2$ is calculated by non-linear interpolation. An example of a mosaic image before and after radiometric balancing is shown in Figure 2.2.

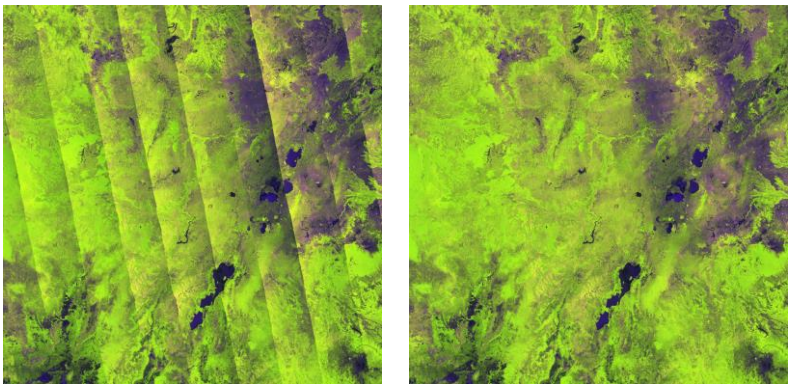

Figure 2.2 2019 PALSAR-2 global mosaic (Ethiopia)
Left: Before radiometric balancing, Right: After radiometric balancing

3 Dataset specification

Table 3.1 Dataset Specification (PALSAR-2/PALSAR)

	25m resolution dataset
Map projection	Geographic coordinates (Latitude/Longitude)
Datum	ITRF97 + GRS80
Data unit (one file)	1 deg. grid in latitude-longitude
Number of pixels for one tile	4500 pixels x 4500 lines
Size of one pixel	0.8 arcsec（approx. 25 m on the Equator）
Data size	160 MB/tile (before compression *)
Content	1. Normalised Radar Backscattering coefficient (Gamma-0) for HH and HV polarizations (HH, HV, VH and VV polarizations for Japan area) 2. Observation date image 3. Local incidence angle image 4. Processing mask information image 5. XML metadata (in compliance with Combined CEOS-ARD for Synthetic Aperture Radar PFS)
Number of tiles (PALSAR)	Year 2007: 24,300, Year 2008: 26,180, Year 2009: 25,007, Year 2010: 26,701
Number of tiles (PALSAR-2)	Year 2015: 22,700, Year 2016: 22,597, Year 2017: 21,576, Year 2018: 21,701 Year 2019: 21,915, Year 2020: 21,699, Year 2021: 21,435, Year 2022: 21,455 Year 2023: 21,430
Original SAR data	PALSAR: Fine Beam Dual mode（off nadir angle: 34.3 deg.; HH+HV） PALSAR-2（Global）: Fine Beam Dual mode（off-nadir angle: F2-5, F2-6, F2-7; HH+HV） PALSAR-2（Gap-fill）: Wide swath Beam Dual mode （off-nadir angle: W2; HH+HV） PALSAR-2（Japan only）: High-sensitive Beam Quad mode（off-nadir angle: FP6-3 to FP6-7, HH+HV+VH+VV）
DEM for processing	AW3D30
SAR algorithm	Sigma-SAR (IMAGE) + Radiometric balancing processing + GDAL

* Actual data size will be smaller due to compression. The data size also varies depending on the area of valid image data within each mosaic tile.

4 Data list and naming convention

The version 2 mosaic datasets have been certified as fully compliant with Combined CEOS-ARD for Synthetic Aperture Radar PFS threshold requirements. CEOS-ARD are satellite data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis with a minimum of additional user effort and interoperability both through time and with other datasets. Please see the following URL for further information about CEOS-ARD.

https://ceos.org/ard/

The data list and its file naming conversion are as follows.

- LLLLLLL: latitude/longitude e.g., North latitude 0 degree, East longitude 100 degrees: LLLLLLL = “N00E100”
- YYYY: year e.g., year 2020: YYYY = “2020”
- M: mode ID e.g., Fine Beam: ”F”, Ultra-fine: “U”
- BB: beam number
- P: number of polarizations e.g., Dual: “D”, Quad: “Q”
- O: ascending orbit = “A”, descending orbit = “D”
- D: right observation = “R”, left observation = “L”

Table 4.1 Data list, naming convention and format

Data list	File name	Data type
Backscattering coefficient (HH pol.)	LLLLLLL_YYYY_sl_HH_MBBPOD.tif	16-bit unsigned integer
Backscattering coefficient (HV pol.)	LLLLLLL_YYYY_sl_HV_MBBPOD.tif	16-bit unsigned integer
Observation date	LLLLLLL_YYYY_date_MBBPOD.tif	16-bit unsigned integer
Local incidence angle	LLLLLLL_YYYY_linci_MBBPOD.tif	8-bit unsigned integer
Processing mask information	LLLLLLL_YYYY_mask_MBBPOD.tif	8-bit unsigned integer

Further descriptions of each data are provided in Section 5.

5 Content of data

5.1 Backscattering coefficient

Data are provided as linear amplitude backscatter, and stored as digital number (DN) in 16 bit unsigned integer format. The DN values can be converted to gamma nought values in decibel unit (dB) using the following equation:

$$\gamma^0 = 10 \log_{10} \langle DN^2 \rangle + CF$$

where, CF is the calibration factor, and the expression within <> is the ensemble squared (power) average value (calculated over a several pixels to reduce the impact of speckle). The CF value is -83.0 (dB) for the PALSAR-2/PALSAR mosaics.

5.2 Observation date image

The pixel digital numbers (DN) in the observation date image represent the number of days after the launch of ALOS-2, on May. 24, 2014 or ALOS, on Jan. 24, 2006. Observation dates are provided in Universal Coordinated Time (UTC).

Example: A DN value of 2580 corresponds to the UTC observation date of June 16, 2021 (24/05/2014 + 2580 days = 16/06/2021) for PALSAR-2 mosaics.

5.3 Local incidence angle image

The pixel digital numbers (DN) in the local incidence angle image represent the angle, expressed in integer degrees[1], between the ground normal at the pixel location and the SAR antenna. DN values are stored as 8 bit unsigned integer (BYTE).

[1] Decimal values converted to integer by truncation.

5.4 Processing mask information image

Table 5.1 shows how to translate values in the mask information image.

Table 5.1 Content of the processing mask information image

Value	Category
0	No data
1	Land (When using ScanSAR data)
2	Lay over (When using ScanSAR data)
3	Shadowing (When using ScanSAR data)
4	Ocean and water (When using ScanSAR data)
50	Ocean and water
100	Lay over
150	Shadowing
255	Land

6 Other information

6.1 Lack of data

In case of lack of data, “No data” (=0) is stored in the processing mask information. Lack of data may be due to that:

- Data are not observed in the target year.
- Data are excluded in the mosaic generation process, e.g. due to strong ionospheric distortion effects, especially common in tropical regions.

6.2 Absolute geometric accuracy

Through the new processing methodology used for the version 2.0.0 datasets and beyond, it has both become possible to increase the processing speed by using GDAL during mosaic processing, and to bring out the high absolute geometric performance of orthorectified image product inherent in the Sigma-SAR processor. As a result, geometric misalignment with previous (Ver.1) mosaic datasets may be observed. This matter is resolved by reprocessing past mosaic data and all products are now released as Ver.2..

6.3 Backscatter variations between paths

Differences in mosaic image brightness from path to path may sometimes be observed, in particular over high latitude areas due to variations in backscattering intensity caused by winter observations during frozen/un-frozen conditions. Other seasonal changes, land cover changes, soil moisture changes, and other phenomena can also cause significant changes in backscattering intensity, resulting in uneven image brightness between adjacent paths also where radiometric balancing has been applied.

Similar path to path differences may also be observed in ocean areas, because radiometric balancing between adjacent paths is only applied over land areas.

7 Note for data use

- JAXA retains ownership of the dataset. JAXA cannot guarantee any problem caused by or possibly caused by using the datasets.
- Anyone wishing to publish any results using the datasets should clearly acknowledge the ownership of the data in the publication.
- For details on JAXA's site policy and terms of use, please check the following URL: https://earth.jaxa.jp/en/data/policy/

8 FAQ and Contact

If you have any questions regarding the use of the dataset, please refer the online “Frequently Asked Questions” (FAQ) on https://www.eorc.jaxa.jp/ALOS/en/inquiry/faq_e.htm

For further questions, please contact the Secretariat of ALOS series Research Group, Earth Observation Research Center (EORC), Japan Aerospace Exploration Agency (JAXA)

E-mail: aproject@jaxa.jp

9 References

- Masanobu Shimada, Takuya Itoh, Takeshi Motooka, Manabu Watanabe, Shiraishi Tomohiro, Rajesh Thapa, and Richard Lucas, "New Global Forest/Non-forest Maps from ALOS PALSAR Data (2007-2010)," Remote Sensing of Environment, 155, pp. 13-31, December 2014. doi.org/10.1016/j.rse.2014.04.014.
- Masanobu Shimada and Takahiro Ohtaki, "Generating Large-Scale High-Quality SAR Mosaic Datasets: Application to PALSAR Data for Global Monitoring", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing 3(4):637 - 656, January 2011. doi.org/10.1109/JSTARS.2010.2077619
- Generation of Global Forest / Non-forest map Using ALOS/PALSAR: (Oct. 21, 2010) https://www.eorc.jaxa.jp/ALOS/en/dataset/fnf/forestmap_oct2010_e.htm
- PALSAR 10 m mosaic: (Nov. 4, 2010) https://www.eorc.jaxa.jp/ALOS/en/dataset/fnf/pal_10m_mosaic_e.htm
- Rosenqvist A., Killough B. (2018), “A Layman’s Interpretation Guide to Synthetic Aperture Radar Data.” Committee on Earth Observation Satellites, CEOS. https://ceos.org/ard/files/Laymans_SAR_Interpretation_Guide_2.0.pdf
- Committee on Earth Observation Satellites. Analysis Ready Data, CEOS-ARD. Product Family Specification: Synthetic Aperture Radar, version 1.0. https://ceos.org/ard/files/PFS/SAR/v1.0/CEOS-ARD_PFS_Synthetic_Aperture_Radar_v1.0.pdf

Appendix Dataset Versions

The following information summarizes the differences between several versions of PALSAR-2/PALSAR global mosaics.

Ver.2.4.0

Version Summary

- AW3D30 Digital Elevation Model Version 4.1 was mainly used for processing. Please see the following URL for further information about AW3D30.

  https://www.eorc.jaxa.jp/ALOS/en/dataset/aw3d30/aw3d30_e.htm

- Products developed to comply with Combined CEOS Analysis Ready Data for Synthetic Aperture Radar PFS (Ver.1.0). (See Table A3).

Release History

May 2024: Datasets for 2023※ are available.

※ 26 cycles of data from 220 to 245 (Dec. 12, 2022 to Dec. 10, 2023) were used.

Ver.2.3.0

Version Summary

- Processed PALSAR global mosaics using the same method as Ver.2.2.0.

Release History

May 2023: Datasets for 2007 and 2010 are available.

August 2023: Datasets for 2008 and 2009 are available.

Ver.2.2.0

Version Summary

- AW3D30 Digital Elevation Model Version 4.0 was used for processing South American Continent, and Version 3.2 was used for the other area. Please see the following URL for further information about AW3D30.

  https://www.eorc.jaxa.jp/ALOS/en/dataset/aw3d30/aw3d30_e.htm

- Gap-filling was applied using ScanSAR ascending data.
- Changed the date format of the filename from YY to YYYY.
- Revised some items of metadata in XML format (See Table A2).

Release History

April 2023: Datasets for 2022※ are available.

※ 26 cycles of data from 194 to 219 (Dec. 13, 2021 to Dec. 11, 2022) were used.

Ver.2.1.2

Version Summary

- Fixed 33 tiles of the year 2020 local incidence angle data which was published as a different data type (16-bit unsigned integer). The replaced tiles are as follows: N70E165, N70E166, N70E167, N70E168, N70E169, N70E170, N70E171, N70E172, N70E173, N70E174, N70E175, N70E176, N70E177, N70E178, N70E179, N71E165, N71E166, N71E167, N71E168, N71E169, N71E170, N71E171, N71E172, N71E173, N71E174, N71E175, N71E176, N71E177, N71E178, N71E179, N72E177, N72E178, N72E179

Release History

September 2022: Datasets for 2015 to 2021 are available.

Ver.2.1.1

Version Summary

- Revised some items of metadata in XML format (See Table A1).

Release History

July 2022: Datasets for 2015 to 2021 are available.

Ver.2.1.0

Version Summary

- Products developed to comply with CEOS Analysis Ready Data for Land, Normalised Radar Backscatter (CARD4L NRB Ver.5.5) specifications. The image data files are provided in Cloud Optimized GeoTIFF (COG) format and metadata in XML format.
- Some tiles are reprocessed to reduce the lack and noise of data.

Release History

June 2022: Datasets for 2015 to 2021 are available.

Ver.2.0.0

Version Summary

- GDAL based mosaicking process to improve absolute geometric accuracy and processing speed.
- AW3D30 Digital Elevation Model used.
- Products developed to comply with CEOS Analysis Ready Data for Land, Normalised Radar Backscatter (CARD4L NRB) specifications. The image data files are provided in GeoTIFF format and metadata in XML format.
- Only data from the target year have been used for each annual mosaic, and hence no gap-filling using data from previous years in case of gaps in the annual global coverage.
- Radiometric balancing between adjacent paths is applied to land data only.

Release History

April 2022: Datasets for 2015, 2016 and 2021 are available.

March 2022: Datasets for 2017 and 2018 are available.

February 2022: Datasets for 2019 and 2020 are available.

Table A1　Comparative table of metadata revisions (1/2)

#	Parameters	Original	Corrected	Notes
1.3	<Product>	<Product type="Normalized Radar Backscatter" copyright="JAXA/EORC" version="5.5">	<Product type="Normalised Radar Backscatter" version="5.5" copyright="JAXA/EORC">	Correct a misspelled word. Changed the order of version and copyright.
1.5	<FirstAcquisitionDate>	<FirstAcquistionDate>	<FirstAcquisitionDate>	Correct a misspelled word.
1.5	<LastAcquisitionDate>	<LastAcquistitionDate>	<LastAcquisitionDate>	Correct a misspelled word.
1.6.2	<SatelliteReference>		https://directory.eoportal.org/web/eoportal/satellite-missions/a/alos-2	Added <SatelliteReference>.
1.6.4	<RadarCenterFrequency>	1.2575	1.2365	Fixed the value from 1.2575 to 1.2365.
1.6.7	<SourceDataGeometry>	Polygon ((37.961518 5.365272, 36.932498 10.543917, 37.603653 10.673287, 38.624039 5.498724, 37.961518 5.365272))	Polygon ((36.932498 10.543917, 37.961518 5.365272, 38.624039 5.498724, 37.603653 10.673287, 36.932498 10.543917))	Placed the value in a counter-clockwise direction.
1.7.6	<ProductGeographicalExtent>	Polygon ((38.000000 9.000000, 39.000000 9.000000, 39.000000 8.000000, 38.000000 8.000000, 38.000000 9.000000))	Polygon ((38.000000 9.000000, 38.000000 8.000000, 39.000000 8.000000, 39.000000 9.000000, 38.000000 9.000000))	Placed the value in a counter-clockwise direction.

Table A1 Comparative table of metadata revisions (2/2)

#	Parameters	Original	Corrected	Notes
2.2	<ByteOrder>	<ByteOrder/>		Removed.
2.4	<ByteOrder>	<ByteOrder/>		Removed.
3.1	<BackscatterConversionEq>	10 * log10(DN^2) - 83.0	10*log10(DN^2)-83.0	Removed the space from the equation.

Table A2 Comparative table of metadata revisions (1/2)

#	Parameters	Original	Corrected	Notes
1.4	<DocumentIdentifier>	<https://ceos.org/ard/files/PFS/NRB/v5.5/CARD4L-PFS_Normalised_Radar_Backscatter-v5.5.pdf>	<https://ceos.org/ard/files/PFS/NRB/v5.5/CARD4L-PFS_NRB_v5.5.pdf>	Correct the URL
1.6.4	<RadarCenterFrequency>	1.2365	1.2365e+09	Changed the unit from GHz to Hz
	<ObservationMode>	FBD or HBQ	Stripmap FBD or HBQ	Added Stripmap
	<RadarBandWidth>	-	2.8e+07 or 4.2e+07	Added <RadarBandWidth>.
1.6.7	<SourceDataGeometry>	Polygon ((36.932498 10.543917, 37.961518 5.365272, 38.624039 5.498724, 37.603653 10.673287, 36.932498 10.543917))	Slant range	Moved to <SourceGeographicalExtent>
	<SourceGeographicalExtent>	-	Polygon ((36.932498 10.543917, 37.961518 5.365272, 38.624039 5.498724, 37.603653 10.673287, 36.932498 10.543917))	Added <SourceGeographicalExtent>

Table A2 Comparative table of metadata revisions (2/2)

#	Parameters	Original	Corrected	Notes
2.2	<ScanSARValidData>	-	1	Added.
	<ScanSARLayover>	-	2	Added.
	<ScanSARShadow>	-	3	Added.
	<ScanSAROceanWater>	-	4	Added

Table A3　Comparative table of metadata revisions to comply with Combined CEOS-ARD for Synthetic Aperture Radar PFS Ver.1.0

#	Parameters	Original	Corrected	Notes
1.3	Product Type	<Product type="Normalised Radar Backscatter" version="5.5" copyright="JAXA/EORC">	<Product type="Normalised Radar Backscatter" copyright="JAXA/EORC">	Removed the “version”.
1.4	Document Identifier	<DocumentIdentifier type="URL"> https://ceos.org/ard/files/PFS/NRB/v5.5/CARD4L-PFS_NRB_v5.5.pdf	<DocumentIdentifier name="CEOS-ARD for Synthetic Aperture Radar" version="1.0" type="URL"> https://ceos.org/ard/files/PFS/SAR/v1.0/CEOS-ARD_PFS_Synthetic_Aperture_Radar_v1.0.pdf	Added “name” and “version”. Changed to the new URL.
1.7	CEOS-ARD Product Attributes	<CARD4LProductAttributes>	<CEOS-ARDProductAttributes>	Renamed.
4.3	Geometric Accuracy	<GeoCorrAccuracy>	<GeoCorrAccuracy type="SlantRange" ALESource="SLC">	Add “Type” and “ALESource”.
	Ionospheric Delay Correction	-	<IonosphericDelayCorrection> <IonosphericDelayCorrectionApplied>FALSE	Add the applicability of the ionospheric delay correction.