Global 25 m Resolution PALSAR-2 Mosaic (Ver.2.1.0)

Dataset Description

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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.

Table of Contents

1 Overview of the dataset

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

The PALSAR-2 global mosaics are free and open annual datasets generated by JAXA using the L-band Synthetic Aperture Radar (PALSAR-2) on the Advanced Land Observing Satellite-2 (ALOS-2). The mosaics have been created by assembling long paths of PALSAR-2 backscatter images observed through the ALOS-2 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 global mosaics fully replace all earlier (version 1) PALSAR-2 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 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 CEOS Analysis Ready Data for Land, Normalized Radar Backscatter (CARD4L NRB) specifications.
- 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.

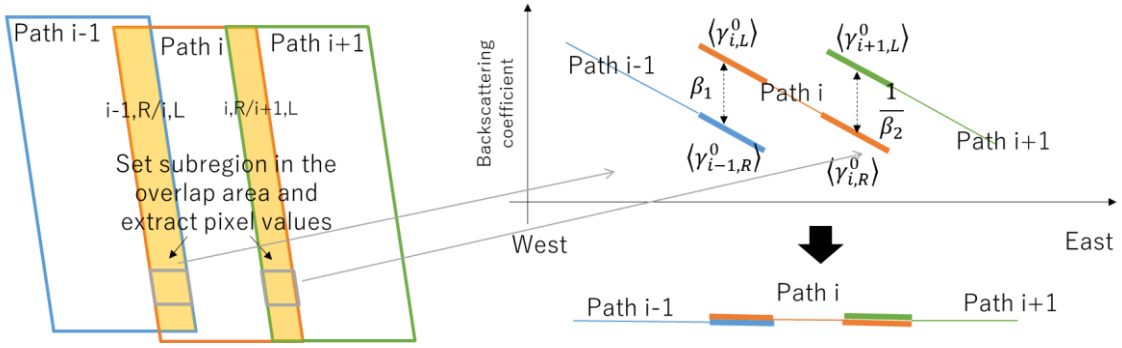

Figure 2.1 A simplified concept of radiometric balancing between adjacent paths.

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.

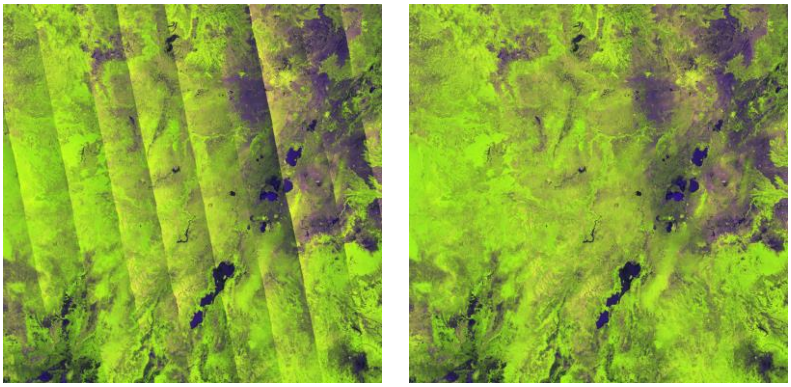

Figure 2.2 2019 PALSAR-2 global mosaic (Ethiopia)
Left: Before radiometric balancing, Right: After radiometric balancing

3 Dataset specification

Table 3.1 Dataset Specification (PALSAR-2)

	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. Normalized Radar Backscattering coefficient (Gamma-0) for HH and HV polarizations 2. Observation date image 3. Local incidence angle image 4. Processing mask information image 5. XML metadata (in compliance with CARD4L NRB Ver 5.5 specifications)
Number of tiles	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
Original SAR data	PALSAR-2（Global）: Fine Beam Dual mode（off-nadir angle: F2-5, F2-6, F2-7; 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 2.0.0 mosaic datasets are developed to meet the requirements for compliance with CEOS Analysis Ready Data for Land, Normalized Radar Backscatter specifications (CARD4L NRB). CARD4L 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 CARD4L.

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”
- YY: year e.g., year 2020: YY = “20”
- 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 (PALSAR-2)

Data list	File name	Data type
Backscattering coefficient (HH pol.)	LLLLLLL_YY_sl_HH_MBBPOD.tif	16-bit unsigned integer
Backscattering coefficient (HV pol.)	LLLLLLL_YY_sl_HV_MBBPOD.tif	16-bit unsigned integer
Observation date	LLLLLLL_YY_date_MBBPOD.tif	16-bit unsigned integer
Local incidence angle	LLLLLLL_YY_linci_MBBPOD.tif	8-bit unsigned integer
Processing mask information	LLLLLLL_YY_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 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. 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).

5.3 Local incidence angle image

The pixel digital numbers (DN) in the local incidence angle image represent the angle, expressed in integer degrees which round the number down after the decimal point, between the ground normal at the pixel location and the SAR antenna. DN values are stored as 8 bit unsigned integer (BYTE).

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
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 expected to be resolved by reprocessing past (ALOS PALSAR and JERS-1 SAR) mosaic data in the future.

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

Appendix Dataset Versions

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

Ver.2.1.0

Version Summary

- Products developed to comply with CEOS Analysis Ready Data for Land, Normalized 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, Normalized 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.