MEaSUREs Greenland Image Mosaics from Sentinel-1A and -1B, Version 2

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Joughin, I. 2017, updated 2019. *MEaSUREs Greenland Image Mosaics from Sentinel-1A and -1B, Version 2.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/GPVL3SACPBW4. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/nsidc-0723

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

The mosaics provided in this data set consist of uncalibrated C-SAR radar backscatter.

1.1.1 Parameter Description

In SAR applications, backscatter is the ratio between the power of a radar pulse transmitted to the target and the power scattered back towards the antenna.

1.1.2 Sample Data Record

Figure 1. Sample mosaic of data collected from 25 January 2015 to 02 February 2015 (file name: S1A_2015-01-25_2015-02-05_mosaic_v01.jpg). Contains modified Copernicus Sentinel data (2015-2017), acquired by the European Space Agency, distributed through the Alaska Satellite Facility, and processed by I. Joughin.

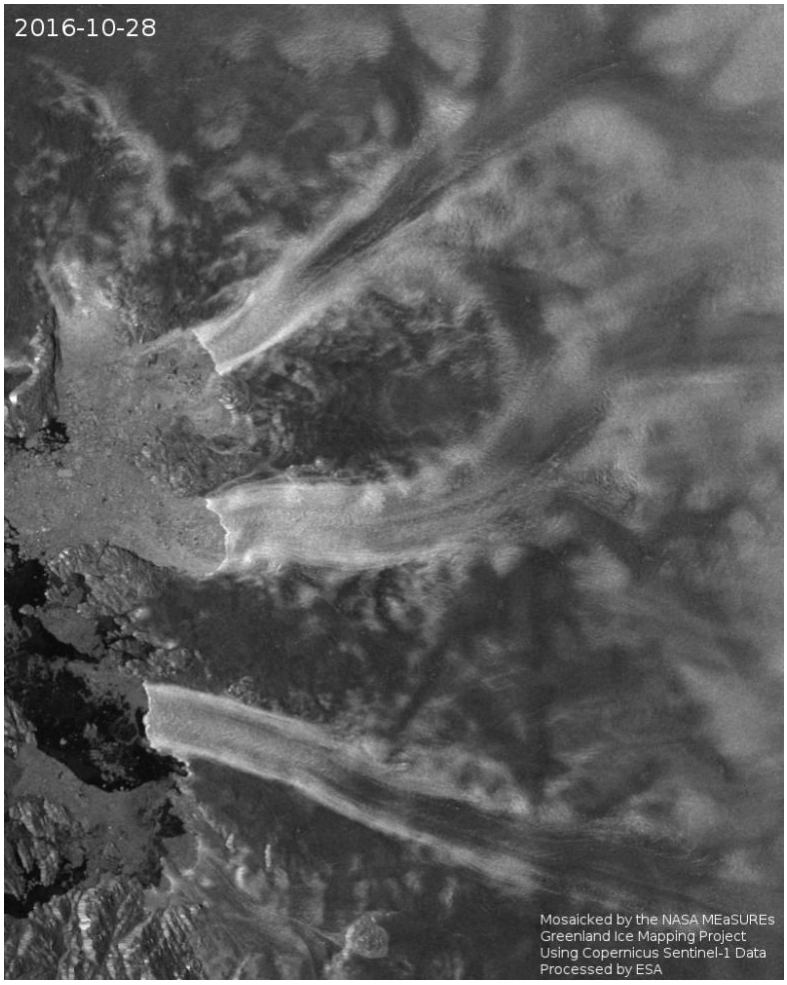

Figure 2. Individual frame from 28 October 2016 from the sample animation upernavik_v02.1.mov, focusing on the glacier termini near Upernavik, Greenland. Contains modified Copernicus Sentinel data (2015-2017), acquired by the European Space Agency, distributed through the Alaska Satellite Facility, and processed by I. Joughin.

1.2 File Information

1.2.1 Format

Each mosaic product spans either a 12-day period (prior to 28 September 2016) or a 6-day period (starting on 28 September 2016). Each mosaic is available in Geographic Tagged Image File Format (GeoTIFF) as a set of four tiles geographically divided into North, Northeast, Northwest, and South regions posted at 50 m, which is approximately equivalent to the image resolution after multi-look averaging. In addition, the following ancillary files are available:

- Shapefiles for each product that provide the dates for the individual images used in each mosaic. In addition to the date, the shapefiles specify the track (relative orbit), orbit (absolute orbit), and particular satellite (S1A/B).

- Geospatial Data Abstraction Library (GDAL) `.vrt` files, which allow the 50 m GeoTIFF files to be opened as a single file in geographical information system (GIS) programs.
- OVR files (`.vrt.ovr`) that contain image pyramids to facilitate rapid viewing of the 50 m mosaics.
- 1-km Quicklook images (`.jpg` and `.jpg.aux.xml`) that provide some geolocation information.

1.2.2 Directory Structure

Data are available via HTTPS in the following directory:

`https://daacdata.apps.nsidc.org/pub/DATASETS/nsidc0723_MEASURES_image_mosaics_v02`

This directory contains folders named by year-month-day (YYYY-MM-DD), where the date corresponds to the first date of the mosaic epoch, and two video files in `.mov` format: `upernavik_v02.1.mov` and `greenland_v02.1.mov`.

1.2.3 Naming Convention

This section explains the file naming conventions with examples of each file type. Tables 1 through 3 describe the variables for each naming convention. Beginning with the November 2017 update, the file names changed to `S1_[start_date]_[end_date]_v02.2.[ext]`, with both S1A and S1B data used in each file. As of February 2018, all file names use this convention.

1.2.3.1 Shapefiles

Naming Convention: `S1_[start_date]_[end_date]_v02.2.[ext]`

Example File Names:

- S1_2015-01-01_2015-01-12_v02.2.dbf
- S1_2015-01-01_2015-01-12_v02.2.prj
- S1_2015-01-01_2015-01-12_v02.2.shp
- S1_2015-01-01_2015-01-12_v02.2.shx

Table 1 describes the variables used in the shapefile naming convention.

Table 1. Naming Convention for Shapefiles

Variable	Description
S1	Sentinel-1 satellites A and B
start_date	Date of first image used in the mosaic period (YYYY-MM-DD)
end_date	Date of last image used in the mosaic period (YYYY-MM-DD)

Variable	Description
v02.2	Version number
.ext	File extension. The shapefile format consists of four files: • .dbf (database file) • .prj (projection information) • .shp (shapes) • .shx (shape indices)

1.2.3.2 Browse JPEGs and Metadata files, GDAL Virtual Files, and GDAL Image Pyramid Files

Naming Convention: `S1_[start_date]_[end_date]_mosaic_v02.2.[ext]`

Example File Names:

- S1_2015-01-01_2015-01-12_mosaic_v02.2.jpg
- S1_2015-01-01_2015-01-12_mosaic_v02.2.vrt
- S1_2015-01-01_2015-01-12_mosaic_v02.2.vrt.ovr
- S1_2015-01-01_2015-01-12_mosaic_v02.2.jpg.aux.xml

Table 2 describes the variables used in the browse file naming convention.

Table 2. Naming Convention for Browse Files

Variable	Description
S1	Sentinel-1 satellites A and B
start_date	Date of first image used in the mosaic period (YYYY-MM-DD)
end_date	Date of last image used in the mosaic period (YYYY-MM-DD)
mosaic	Denotes that the file is a multiyear mosaic file
v02.2	Version number
.ext	File extensions: • .jpg (JPEG) • .vrt (GDAL virtual format) • .vrt.ovr (GDAL OVR pyramid format) • .jpg.aux.xml (Extensible Markup Language)

1.2.3.3 GeoTIFFS

Naming Convention: `S1_[start_date]_[end_date]_[region]_v02.2.tif`

Example File Names:

- S1_2015-01-01_2015-01-12_south_v02.2.tif
- S1_2015-01-01_2015-01-12_northwest_v02.2.tif

- S1_2015-01-01_2015-01-12_northeast_v02.2.tif
- S1_2015-01-01_2015-01-12_north_v02.2.tif

Table 3 describes the variables used in the GeoTIFF file naming convention.

Table 3. Naming Convention for GeoTIFF Files

Variable	Description
S1	Sentinel-1 satellites A and B
start_date	Date of first image used in the mosaic period (YYYY-MM-DD)
end_date	Date of last image used in the mosaic period (YYYY-MM-DD)
region	Regions of Greenland: north, northeast, northwest, or south
v02.2	Version number

1.3 Spatial Information

1.3.1 Coverage

The study area lies within the following bounding box:

- Southernmost Latitude: 60° N
- Northernmost Latitude: 82° N
- Easternmost Longitude: 20° W
- Westernmost Longitude: 70° W

1.3.2 Resolution

The spatial resolution is 50 m x 50 m.

1.3.3 Projection and Grid Description

GeoTIFFs are provided in a WGS 84 polar stereographic grid with a standard latitude of 70° N and rotation angle of -45° (sometimes specified as a longitude of 45° W). With this convention, the y-axis extends south from the North Pole along the 45° W meridian (EPSG:3413).

The 50 m mosaics are provided as a set of 4 tiles, divided and named by geographic region: north, northeast, northwest, and south.

1.4 Temporal Information

1.4.1 Coverage

Start date: 01 January 2015 (ongoing)

This data set undergoes periodic updates as new Sentinel data are collected and processed.

1.4.2 Resolution

The temporal resolution for data acquired prior to 28 September 2016 is 12 days. The temporal resolution for data acquired after 28 September 2016 is 6 days.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The interactions between radar signals and the ground depend upon many factors, such as the density and dielectric properties of surface materials, vegetation cover, surface roughness at the scale of the signal's wavelength, topographic variations, and the instrument's look angle and signal polarization. The image resolution is particularly affected by signal strength, chirp pulse length and bandwidth, return signal integration time, and the time between pulse transmissions.

For a detailed discussion of SAR theory, see SAR Theory/Interpreting Images (PDF, 82.4 KB). For general information about the mathematical derivations and theories behind SAR processing algorithms, see Scientific SAR User's Guide (PDF, 296 KB).

2.2 Acquisition

Copernicus Sentinel-1A and -1B satellite imagery was acquired by the European Space Agency and archived and distributed through the Alaska Satellite Facility.

From 01 January 2015 to 15 September 2016, data were acquired from the Sentinel-1A platform only. Beginning 28 September 2016, data were acquired from both Sentinel-1A and Sentinel-1B platforms.

2.3 Processing

The Alaska Satellite Facility provided all source data as Level-1 burst Single-Look Complex (SLC) data, including digitized voltage values, instrument calibration constants, satellite timing, attitude, and position information. The SLC burst data were processed to full multi-burst SLC scenes using the GAMMA Modular SAR Processor (MSP) package.

The data have been mapped to grey scale values in the range of 0 - 255 (bytes) using a nonlinear stretch to allow visual discrimination of topographical features within the images. As a result, the

pixel values for each year are not directly comparable; however, if no change has occurred, they should be relatively consistent from scene to scene.

The mosaics are produced from four descending and two ascending tracks. In some cases, the image tracks overlapped, but at any given pixel, only one image was used. If the overlapping images were ascending (Tracks 74 and 90) and descending (Tracks 26, 112, 141, 170), the descending image was used (see the shapefile attribute field to determine track direction). If two parallel images overlapped, the top polygon in the shapefile should correspond to the image that was included in the mosaic. In some locations, it is possible that one mosaic will have ascending geometry and another descending geometry because of missed acquisitions (i.e., a consistent geometry is used whenever sufficient data are acquired). In such areas, mountains and other topography features will appear to be illuminated from opposite sides. If the images are flickered between, the different viewing geometries can give the impression of large shifts, even though the data are generally well registered. For regions with like-viewing geometry, the co-registration is far better than the 50-m posting, except in cases where the topography is extreme.

NOTE: In instances where no viable data were available, a blank tile (.tif) was still generated. The JPEG file (.jpg) that accompanies each four-tile mosaic provides a quicklook view of expected data output when all four tiles are combined.

2.4 Quality, Errors, and Limitations

2.4.1 Error Sources

With the exception of extreme terrain regions, geometric accuracy is better than a single 50 m pixel (Joughin et al., 2016).

2.4.2 Terrain Correction

The data were terrain-corrected with *MEaSUREs Greenland Ice Mapping Project (GIMP) Digital Elevation Model*, Version 1. Due to this correction, some slight differences in registration relative to *MEaSUREs Greenland Ice Sheet Mosaics from SAR Data*, Version 1, mosaics exist.

2.5 Instrumentation

2.5.1 Description

For more information on the SAR satellites Sentinel-1A and -1B, please see the European Space Agency's Copernicus Sentinel-1 web page.

3 SOFTWARE AND TOOLS

GeoTIFF files can be viewed with a variety of Geographic Information System (GIS) software packages including:

Blue Marble Geographics Global Mapper
QGIS
GDAL
Esri ArcGIS

For details about the shapefile format, see the ESRI Shapefile Technical Description (PDF, 124 KB). The VRT format is discussed in detail on the GDAL Virtual Format Tutorial web page. The ArcGIS Resource Center's Raster Pyramids and OVR Pyramid Files help pages provide more information about raster data set downsampling.

4 VERSION HISTORY

Table 4. Version History

Version	Description	Effective Date
V2.2	Updated the `.tif` file names within the `.vrt` files to match the actual `.tif` files. The `.gif` files changed were changed to .mov files.	September 2019
V2.1	An additional track (Sentinel-1, track 83) is included to improve coverage in the southern part of the ice sheet. This will change the geometry for a small region in the southwest from ascending to predominantly descending from May 2017 forward when track 83 is available. May 2017 v2.0 and June 2017 v2.0 files were replaced. July 2017 data were added.	September 2017
V2	• Data were reprocessed with a small radiometric correction to improve consistency across seam boundaries. • Temporal coverage was expanded through 31 May 2017. • Dates were added to the .gif files.	July 2017
V1	Initial release	June 2017

5 RELATED DATA SETS

MEaSUREs Greenland Ice Mapping Project (GIMP) Digital Elevation Model
MEaSUREs Greenland Ice Sheet Mosaics from SAR Data
Greenland Ice Sheet Mapping Project (GIMP)

6 RELATED WEBSITES

MEaSUREs at NSIDC | Overview
European Space Agency (ESA)
Alaska Satellite Facility (ASF)

7 CONTACTS AND ACKNOWLEDGMENTS

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8 REFERENCES

Joughin, I., Smith, B. E., Howat, I. M., Moon, T., & Scambos, T. A. (2016). A SAR record of early 21st century change in Greenland. Journal of Glaciology, 62(231), 62–71. https://doi.org/10.1017/jog.2016.10

9 DOCUMENT INFORMATION

9.1 Publication Date

June 2017

9.2 Date Last Updated

September 2019