MEaSUREs Annual Greenland Outlet Glacier Terminus Positions from SAR Mosaics, Version 2

USER GUIDE

How to Cite These Data

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

Joughin, I., T. Moon, J. Joughin, and T. Black. 2021. *MEaSUREs Annual Greenland Outlet Glacier Terminus Positions from SAR Mosaics, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/ESFWE11AVFKW. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0642

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This data set consists of annual, digitized (polyline) ice front positions for 239 outlet glaciers in Greenland. Ice front positions are derived from Sentinel-1A, Sentinel-1B, and RADARSAT-1 synthetic aperture radar (SAR) mosaics, plus imagery from Landsat 1 through Landsat 5 and Landsat 7 and Landsat 8. Although temporal coverage varies by glacier, data are available for the winter seasons 1972–1973 through 2020–2021.

1.1 Parameters

1.1.1 Parameter Description

Data are provided as annual shapefiles. Each shapefile contains all the available ice front (terminus) positions for that winter season, digitized as polylines. A separate glacier ID shapefile is provided that contains point locations and names for all glaciers in the data set. Table 1 and Table 2 describe the attributes that are included in the termini shapefiles and the glacier ID shapefile, respectively:

Table 1. Attributes For Ice Front Location (Termini) Shapefiles

Attribute	Description	Values
Glacier_ID	Numerical ID for each glacier across all data sets	1 – 239
Quality_FI	Quality flag	0. no flag 1. terminus position estimated or uncertain (see Section 2.3) 2. position uncertainty improved or verified using Landsat imagery 3. Landsat-7 scan-line corrector (SLC) failure affected digitization.
Image_ID	Unique identifier for image used to digitize terminus position	See Table 3. Naming Convention For Image_ID Attribute”
Sensor	Satellite source of image used to digitize terminus position	LC08 – Landsat-8 LE07 – Landsat-7 RAD1 – Radarsat-1 SEN1 – Sentinel-1

Attribute	Description	Values
SourceDate	Year, month, and day of image used to digitize terminus position	YYYY-MM-DD

Table 2. Attributes For Glacier ID Shapefile

Attribute	Description	Values
GlacierID	Numerical ID for each glacier (used consistently across all data sets)	1 – 239
POINT_X	X-coordinate, glacier point location	See "Table 4. Geolocation Details"
POINT_Y	Y-coordinate, glacier point location	
GrnlndcNam	Greenlandic glacier name	Values are standardized to match "New Greenlandic" attribute in database of Greenland glacier names (Bjørk et al., 2015).
Official_n	Officially recognized glacier name	Values are standardized to match "Official_n" attribute in database of Greenland glacier names (Bjørk et al., 2015).
AltName	Alternative glacier name	Includes e.g., foreign name or Old Greenlandic name (Bjørk et al., 2015), or other recognized names.

The following table describes the naming conventions in the Image_ID attribute (the source images used to digitize glacier terminus positions):

Table 3. Naming Convention For Image_ID Attribute

Satellite	ID Naming Convention
Sentinel-1[1]	SEN1_NSIDC_0723_Vx_YYYYMMDD_yyyymmdd • x – Sentinel mosaic version • YYYYMMDD – mosaic start date • yyyymmdd – mosaic end date
RADARSAT-1[2]	RAD1_NSIDC_0633_Vxx_20_YYyy • V[xx] – Radarsat mosaic version number • YY – last two digits of mosaic start year • yy – last two digits of mosaic end year

Satellite	ID Naming Convention

Landsat[3]	LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX
	• L = Landsat
	• X = Sensor
	  • C = OLI/TIRS combined
	  • O = OLI-only
	  • T = TIRS-only
	  • E = ETM+
	  • T = TM
	  • M = MSS
	• SS = Satellite (07 = Landsat 7, 08 = Landsat 8)
	• LLLL = Processing correction level (L1TP, L1GT, or L1GS)
	• PPP = WRS path
	• RRR = WRS row
	• YYYYMMDD = Acquisition year, month, day
	• yyyymmdd = Processing year, month, day
	• CC = Collection number (01, 02, …)
	• TX = Collection category (RT = Real-Time, T1 = Tier 1, T2 = Tier 2)

[1]See MEaSUREs Greenland Image Mosaics from Sentinel-1A and -1B (NSIDC-0723)

[2]See MEaSUREs Greenland Ice Sheet Mosaics from SAR Data (NSIDC-0633)

[3]Landsat source images retain the USGS naming convention. For more information, see "What is the naming convention for Landsat Collections Level-1 scenes?"

1.1.2 Sample Data Record

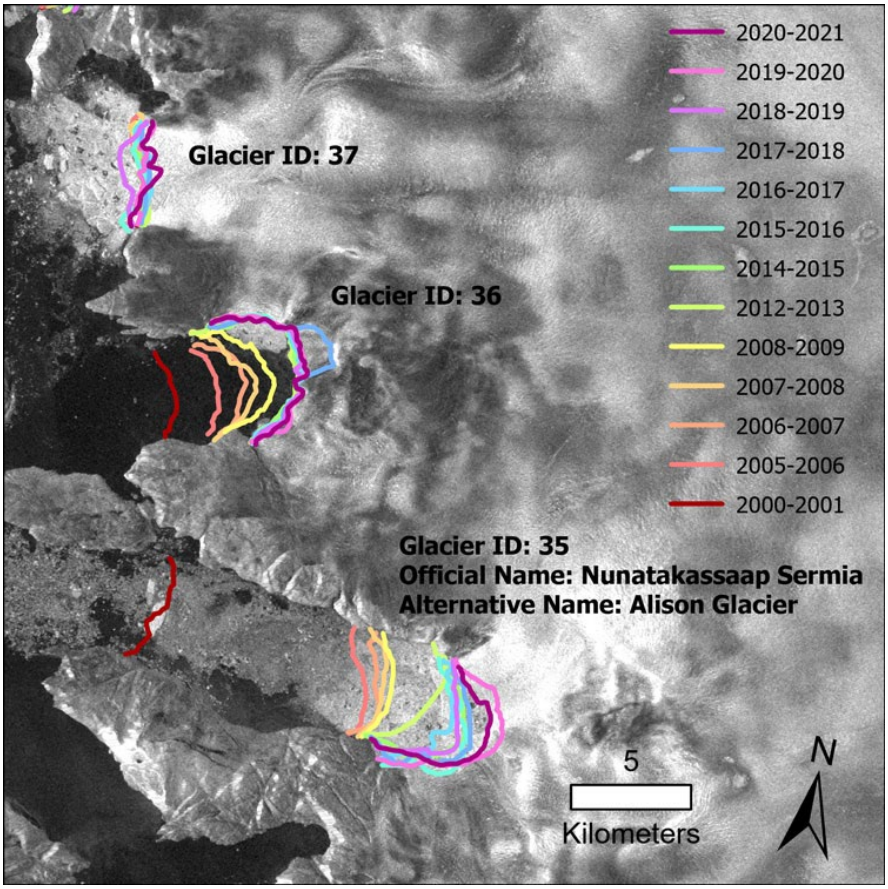
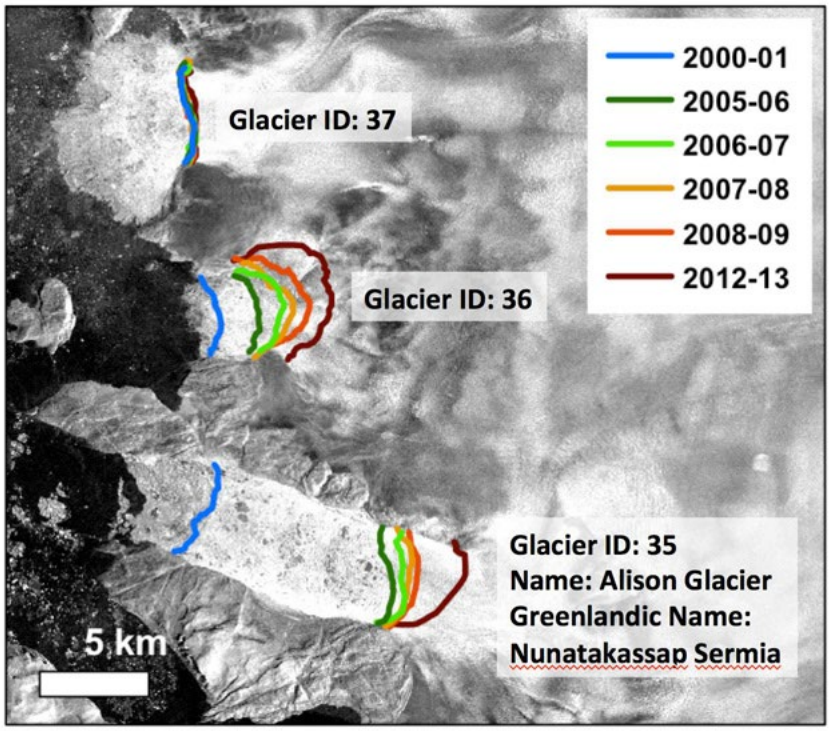


Figure 1. Example Data Visualization



1.2 File Information

1.2.1 Format

Data are provided as Esri shapefiles. A shapefile is a vector data storage format that contains multiple files. The shapefiles in this data set include the following files:

.shp – stores the feature geometry
.shx – stores the index of the feature geometry
.dbf – dBASE table that stores the attribute information
.sbn, .sbx – stores the spatial index of the features
.prj – stores the coordinate system information
.cpg – specifies the code page for identifying the character set to be used
.xml – metadata file

1.2.2 Directory Structure

Data are available from NASA's Earthdata Search or via direct download.

When using the direct download option, the top-level directory contains subfolders—one for each winter season—that store the termini shapefile for that winter. Subfolder names reflect the year, month, and day of the earliest data in that winter season's termini shapefile. For example, the shapefile for the 1972–1973 winter season (termini_1972_1973_v02.0) is stored in the folder named 1972.09.16. Note that the earliest data for a given winter season may not occur until after January 1. For example, the shapefile for the 1973–1974 winter season (termini_1973_1974_v02.0) is stored in the folder named 1974.03.26.

The glacier ID shapefile is stored in subfolder for the 1972–1973 winter season (1972.09.16).

1.2.3 File Naming Convention

1.2.3.1 Glacier ID Shapefile

The glacier ID shapefile (stored in the ????–???? subfolder) consists of the following files:

GlacierIDs_v02.0.cpg
GlacierIDs_v02.0.dbf
GlacierIDs_v02.0.prj
GlacierIDs_v02.0.sbn
GlacierIDs_v02.0.sbx
GlacierIDs_v02.0.shp
GlacierIDs_v02.0.shp.xml
GlacierIDs_v02.0.shx

1.2.3.2 Termini Shapefiles

Termini shapefiles comprise the same eight file types as the glacier ID shapefile. They use the following naming convention:

Example File Name

termini_1972_1973_v02.0.shp

Naming Convention

termini_[YYYY_yyyy]_[v02.0].[ext], where:

- YYYY_yyyy = winter season
- v02.0 = version 2.0
- ext = file extension (See “Section 1.2.1 | Format”.)

1.3 Spatial Information

1.3.1 Coverage

Data are provided for 239 individual glaciers within the following boundaries:

Southernmost Latitude: 60° N
Northernmost Latitude: 83° N
Westernmost Longitude: 75° W
Easternmost Longitude: 14° W

1.3.2 Resolution

The nominal uncertainty in digitized terminus locations is 50 m, but may be larger if the source imagery exhibits poor contrast at the terminus (e.g., tidewater glaciers with persistent melange). Nominal ground resolution for the source mosaics and imagery ranges between 15 m and 50 m.

1.3.3 Geolocation

The following table provides information about geolocating this data set:

Table 4. Geolocation Details

Geographic coordinate system	WGS 84
Projected coordinate system	WGS 84/NSIDC Sea Ice Polar Stereographic North
Longitude of true origin	-45°
Latitude of true origin	70°
Scale factor at longitude of true origin	1

Datum	World Geodetic System 1984
Ellipsoid/spheroid	WGS 84
Units	meters
False easting	0.00000000
False northing	0.00000000
EPSG code	3413
PROJ4 string	+proj=stere +lat_0=90 +lat_ts=70 +lon_0=-45 +k=1 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs
Reference	http://epsg.io/3413

1.4 Temporal Information

1.4.1 Coverage

Temporal coverage spans the winter seasons 1972–1973 to 2020–2021. Note that the date of the source image that was digitized to produce each glacier's terminus position can lie anywhere within that winter season's date range. Users should consult the "SourceDate" attribute (see Table 1) to determine the exact date associated with a glacier's terminus location.

1.4.2 Resolution

One ice front position per year per glacier. However, ice front positions are not available for all years and all glaciers.

2 DATA ACQUISITION AND PROCESSING

2.1 Acquisition

Ice front positions have been digitized from a variety of sources, including base maps in the MEaSUREs Greenland Ice Sheet Mosaics from SAR Data (NSIDC-0633) and MEaSUREs Greenland Image Mosaics from Sentinel-1A and -1B, Version 2 (NSIDC-0723) data sets, plus imagery from the Landsat 1 through Landsat 5 and Landsat 7 and Landsat 8 missions.

2.2 Derivation Techniques and Algorithms

From 2000 through 2013, most termini were digitized from mosaics of RADARSAT satellite data. For the most recent 7 years (2014–2015 through 2020–2021), terminus positions were traced in mosaics of Copernicus Sentinel-1A and Sentinel-1B imagesSentinel-1 data were used starting with

the 2014–2015 winter season. Images acquired by Landsat missions were used to construct terminus positions prior to 2000–2001 (see Black and Joughin, 2022) and to fill gaps in mosaic coverage throughout the data record.

Positions have been digitized for termini with widths of roughly 1.5 km or greater. With few exceptions, all glaciers that appear in each winter season's source mosaic and meet the width criteria have been digitized.

In cases where a terminus was highly fractured, its position does not include any areas which were fully detached (fractured). In some cases, this determination may be subjective.

Complete details are available in Bjørk et al., 2015; Joughin et al., 2016; and Black and Joughin, 2022.

2.3 Quality, Errors, and Limitations

Image quality varies and should be considered on a per-glacier basis. Errors in digitized terminus location may occur due to:

- Image distortion caused by local topography
- Difficulty distinguishing intact glacier ice from an adjacent glacier or sea ice
- Highly fractured terminus areas
- Resolution limits
- Manual digitization error

Polylines cover *roughly* the full width of the active glacier terminus; line ends do not necessarily indicate a junction between ice and rock or any other defined measure of a glacier's edge. As such, this data set should not be used to measure terminus width.

2.4 Instrumentation

2.4.1 Description

For information about the SAR systems used to construct the mosaics from which this data set is derived, see the Alaska Satellite Facility's SAR Basics web page, the Japan Aerospace Exploration Agency (JAXA) About ALOS - PALSAR site, and the European Space Agency's Copernicus Sentinel-1 site. Information about Landsat is available on the USGS Landsat Satellite Missions web site.

3 VERSION HISTORY

Consult the following table for this data set's version history:

Table 5. Version History

Version	Description
V2.0 (May 2022)	• Landsat imagery used to extend temporal coverage to 1972–1973 through 2020–2021 for glaciers with IDs 1–75 and 79–90.
V2.0 (Oct. 2021)	• Temporal coverage extended through winter 2020–2021. • Gaps in mosaic coverage throughout the data record filled using Landsat-7 and Landsat-8 imagery. Every winter season now contains terminus locations for every glacier. • Data quality flags added for some pre-2014 terminus positions.
V1.2 (Oct. 2017)	Added glaciers to two winters: • 2006/2007 – glaciers 90 and 91 • 2008/2009 – glaciers 1-9, 90, and 91
V1.1 (Aug. 2017)	Minor changes include: • Added data for winters of 2014/2015, 2015/16, 2016/17 • Added new parameter attributes for the new data • Added 29 new glaciers • Provided a new GlacierID file with added glaciers and updated attributes
V1 (Sep. 2015)	Initial release

4 RELATED DATA SETS

Digital SAR Mosaic and Elevation Map of the Greenland Ice Sheet
RAMP AMM-1 SAR Image Mosaic of Antarctica
MEaSUREs Greenland Ice Sheet Mosaics from SAR Data
MEaSUREs Greenland Ice Sheet Velocity Map from InSAR Data
MEaSUREs Greenland Ice Velocity: Selected Glacier Site Velocity Maps from InSAR
MEaSUREs InSAR-Based Antarctica Ice Velocity Map
MEaSUREs InSAR-Based Ice Velocity Maps of Central Antarctica: 1997 and 2009
MEaSUREs InSAR-Based Ice Velocity of the Amundsen Sea Embayment, Antarctica

5 RELATED WEBSITES

MEaSUREs Data | Overview
Alaska Satellite Facility
Canadian Space Agency
Japan Aerospace Exploration Agency

6 CONTACTS AND ACKNOWLEDGMENTS

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7 REFERENCES

Bjørk, A. A., L. M. Kruse, and P. B. Michaelsen. 2015. Brief communication: Getting Greenland's glaciers right – a new data set of all official Greenlandic glacier names. *The Cryosphere* 9(6): 2215-2218. doi: https://doi.org/10.5194/tc-9-2215-2015.

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Joughin, I., B. Smith, I. Howat, T. Moon, and T. Scambos. 2016. A SAR record of early 21st century change in Greenland, *Journal of Glaciology* 62: 62-71. https://doi.org/10.1017/jog.2016.10

8 DOCUMENT INFORMATION

8.1 Publication Date

October 2021

8.2 Date Last Updated

May 2022