MEaSURES Greenland Ice Velocity: Selected Glacier Site Velocity Maps from Optical Images, Version 1

USER GUIDE

How to Cite These Data

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

Howat, I. 2016. *MEaSURES Greenland Ice Velocity: Selected Glacier Site Velocity Maps from Optical Images, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/EYV1IP7MUNSV. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/nsidc-0646

NSIDC National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

1.1.1 Parameter Description

This data set reports the following parameters:

- Ice velocities (x- and y-components)
- Error estimates (x- and y-components)

Corresponding ASCII text metadata files (.meta) are also provided that contain geographical information plus dates and codes that reveal the sensor combinations of the images used to create the monthly mean. The sensor combination key is provided in Table 1:

Table 1. Sensor Key for Metadata Files

Sensor	Code
Landsat 8 OLI	LC8
Landsat 7 ETM+	LE7
ASTER	AST

The following sensor combinations are possible: LE7/LE7, LE7/LC8, AST/AST, LC8/LC8.

1.2 File Information

1.2.1 Format

This data set is organized into 49 study sites. The following files are provided for each site:

- velocity browse image (PNG)
- component velocity in the x-direction (GeoTIFF)
- component velocity in the y-direction (GeoTIFF)
- error estimates in the x-direction (GeoTIFF)
- error estimates in the y-direction (GeoTIFF)
- metadata file (ASCII text)

1.2.2 Directory Structure

Study sites in this data set correspond to geographical sub-regions of Greenland. The name of each sub-region reflects its center latitude. Table 3 under the Spatial Coverage section of this document lists the name (center latitude) of each sub-region, the latitude and longitude of its lower left corner, and the geographical features it contains. Data are available via HTTPS in the following directories:

https://daacdata.apps.nsidc.org/pub/DATASETS/nsidc0646_MEASURES_greenland_vel_optical_v1

These directories are divided into folders for each study site. Data files are stored in subfolders labeled by date of acquisition.

1.2.3 Naming Convention

This section explains the file naming convention used for this data.

Example File Names:

- OPT_E61.10N_1999-09.png
- OPT_E61.10N_1999-09.vx.tif
- OPT_E61.10N_1999-09.vy.tif
- OPT_E61.10N_1999-09.ex.tif
- OPT_E61.10N_1999-09.ex.tif
- OPT_E61.10N_1999-09.meta

Naming Convention:

- OPT_[sub-region]_[date].[datum].[ext]

The following table describes the variables used in this data set's file naming convention:

Table 2. File Name Variables and Descriptions

Variable	Description
OPT	Velocities derived from optical image pairs acquired by Landsat 8 OLI, Landsat 7 ETM+, ASTER, or a combination.
sub-region	Sub-region is defined as follows: • E, W, or S: East, West, or South Coast • Center latitude in degrees, minutes
datum	Component velocity or component error estimate: • vx: x component of velocity • vy: y component of velocity • ex: x component of error • ey: y component of error

Variable	Description
ext	File extension: • png: Portable Network Graphic file • tif: GeoTIFF-formatted file • meta: ASCII text file. Contains image dates, production date, sensor combinations, and geographical information

1.3 Size

GeoTIFF files are approximately 1.5 MB each. Browse images and metadata files are less than 50 KB each.

1.4 Volume

The total data volume is approximately 21 GB.

1.5 Spatial Information

1.5.1 Coverage

This data set contains velocity maps for most of the outlet glaciers on the Greenland Ice Sheet. 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

1.5.2 Resolution

100 m

1.5.3 Geolocation

Data are organized into 49 sub-regions of a 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. Table 3 lists the name (center latitude) of each sub-region, the latitude and longitude of its lower left corner, and the glaciers it contains.

Table 3. Sub-Region Names, Locations, and Geographical Features

Sub-Region Name • Latitude, Longitude (lower left corner)	Geographical Features in Grid
E61.10N • 60.8004, -43.9589	• Unnamed glacier near Danell Fjord • Danells • Kanderdluluk Fjord • Cape Herluf Trolle • Cape Tordenskjold
E61.70N • 61.3903, -43.7671	• Anorituup Kangerlua Fjord • Napasorsuaq Fjord
E62.10N • 61.801, -43.2149	• Puisortoq Glacier (north) • Puisortoq Fjord (south)
E62.55N • 62.2422, -43.6371	• Mogens Heinesen Fjord • Timmiarmiut Fjord
E63.00N • 62.7212, -43.5332	• Heimdal Glacier
E63.35N • 63.0911, -42.5656	• Thrym Glacier • Sehested Fjord • Skinfaxe Glacier
E63.85N • 63.5620, -42.4419	• Bernstorffs Fjord
E64.35N • 64.0768, -42.2688	• Gyldenlove Fjord
E64.65N • 64.3291, -41.7539	• Fridtjof Nansens Peninsula
E65.10N • 64.7987, -41.8569	• Koge Bay
E65.55N • 65.2242, -40.5156	• Ikertivaq Sound • Pamiatig
E66.50N • 66.1973, -39.1116	• Fenris Glacier • Helheim Glacier
E66.60N • 66.3305, -37.4428	• Midgard Glacier • Midgard North
E66.90N • 66.5045, -36.2923	• Kruuse Fjord • Steenstrup Glacier • Tasiilaq Fjord
E67.55N • 67.2762, -34.9643	• Norde Parallel Glacier • Nordre

Sub-Region Name • Latitude, Longitude (lower left corner)	Geographical Features in Grid
E68.05N • 67.9148, -33.9170	• Hutchinson Glacier
E68.50N • 68.3044, -31.1040	• Courtauld Glacier • Frederiksborg Glacier • Christian IV Glacier • Sorgenfri Glacier
E68.52N • 68.3044, -31.1040	• Schjelderup Glacier • Sorgenfri Glacier
E68.80N • 68.4663, -34.3672	• Kangerdlussuaq Glacier • Nordfjord Glacier
E69.90N • 69.8224, -29.5537	• unnamed glaciers
E70.10N • 70.0023, -26.7390	• Syd Glacier
E70.40N • 70.0488, -30.6613	• Rolige Glacier
E71.75N • 71.4887, -30.9758	• Daugaard-Jensen Glacier
E71.95N • 71.7410, -29.9742	• Daugard-Jensen Glacier
E78.95N • 78.7851, -22.2120	• Gammel Hellerup Glacier
W61.70N • 61.4746, -48.4912	• Sermiligarssuk Fjord
W62.10N • 61.8077, -49.0172	• Nigerdlikasik Glacier • Avangnardleq Glacier • Ukassorssuaq
W64.25N • 63.9263, -49.8721	• Kangiata Nunata Sermia Glacier • Quamanarssup Glacier
W64.75N • 64.4610, -50.1732	• Ujarassuit Paauat Fjord • Narsap Sermia Glacier
W69.10N • 68.7418, -50.4126	• Alangordliup Sermia Glacier • Jakobshavn Isbræ Glacier • Torsukattak Glacier
W69.95N • 69.6356, -50.6122	• Kangilerngata Sermia Glacier • Kujatdleq Glacier • Torsukattak Fjord

Sub-Region Name • Latitude, Longitude (lower left corner)	Geographical Features in Grid
W70.55N • 70.2285, -50.9177	• Lille Glacier • Sermilik Glacier • Kangilleq Glacier • Store Glacier
W70.90N • 70.7542, -50.9613	• Perdlerfiup Sermis Glacier • Silardleq
W71.65N • 71.3100, -51.8327	• Kangerluarsuk Glacier • Rink Glacier
W72.00N • 71.6540, -52.8014	• Inngia Fjord • Umiammakku Glacier
W72.90N • 72.5829, -54.8293	• Alangorssup Sermia Glacier • Upernavik Isstorm Glacier
W73.45N • 73.1520, -55.6912	• Kakivfait Sermiat Glacier • Giesecke Glacier • Nutarmiut Glacier • Tuvssaq (populated area)
W73.75N • 73.1520, -55.6912	• Cornell Glacier • Sugarloaf Bugt (sound) • Ussing Glacier
W74.50N • 74.1506, -56.4843	• Cornel Glacier • Alison Bugy (bay) • Illulik (populated area)
W74.95N • 74.5750, -57.6463	• Hays Glacier • Kjer Glacier • Jensen Glacier
W75.50N • 75.1264, -58.5281	• Dietrichson Glacier • Steenstrup Glacier • Sverdrup Glacier
W75.85N • 75.4736, -59.2722	• Nansen Glacier • Nordenskiold Glacier
W76.10N • 75.7205, -60.0987	• Kong Oscar Glacier • Nordenskiold Glacier • Nutarmiut
W76.25N • 75.9067, -61.2365	• Balgoni • Docker Smith Glacier • Fisher • Igssuarssuit Sermia Glacier • Leven

Sub-Region Name • Latitude, Longitude (lower left corner)	Geographical Features in Grid
W76.33N • 76.1538, -64.2165	• Yngvar Nielsen Glacier • Mohn Glacier
W76.35N • 75.7416, -63.3988	• Mohn Glacier • Gade Glacier • Meteor Bay • Yngvar Nielson Glacier
W77.55N • 77.0728, -66.2296	• Leidy Glacier • Mane Glacier • Heilprin Glacier • Mellville Glacier • Tracy Glacier
S44.84W • 61.0923, -45.3465	• Kiattuut Sermiat glacier • Qooroq Fjord
S45.43W • 61.2196, -45.8994	• Equlorutsit Kangigdlit • Sermia

1.6 Temporal Information

1.6.1 Coverage

Data span July 1999 through September 2015.

1.6.2 Resolution

Monthly

2 DATA ACQUISITION AND PROCESSING

2.1 Acquisition

Level 1 imagery for the Landsat 7 ETM+ and Landsat 8 OLI was obtained from the U. S. Geological Survey (USGS | Landsat Level 1 Standard Data Products). ASTER (AST14DMO) imagery was obtained from the NASA Land Processes Distributed Active Archive Center (LPDAAC).

2.2 Derivation Techniques and Algorithms

2.2.1 Processing Steps

These data were created using orthorectified Landsat Level L1T or L1G and ASTER (AST14DMO) imagery. Orthorectified images were received in UTM projection and converted to Polar Stereographic using Geographic Data Abstraction Library (GDAL) software. ASTER visible bands 1-3 were reduced to a single grayscale principle component image. The panchromatic band was used for Landsat. Velocity fields were constructed using images from the same sensor or combinations of Landsat 7, Landsat 8, and ASTER images. In the case of Landsat pairs, only images from the same path/row were used to reduce the impact of terrain-dependent errors.

Velocity fields were produced by an automated cross-correlation of sequential images using the Multi-Image Multi-Chip (MIMC) algorithm described in Ahn and Howat (2011) and updated in Jeong et al. (in revision). The MIMC utilizes a range of image filters and search window sizes as well as both backward and forward matching to generate 64 matches per sample. Neighborhood statistics and an *a priori* velocity field, consisting of radar-derived velocities closest in time to the image dates from the MEaSUREs Greenland Ice Sheet Velocity Map from InSAR Data data set, were used to select the highest confidence solution and its uncertainty.

This velocity field was then corrected for image re-registration errors by subtracting the average displacement over bedrock or very slow-moving ice (< 10 m/yr), which is located using the *a priori* velocity field. The residual deviation of velocities over bedrock then provides the registration error (see Error Sources). Individual velocity image pairs within each region were sampled to the same grid and stacked into monthly medians at each grid point, providing a monthly sampling. The median error was also obtained.

Note: Monthly means are calculated from images which may have acquisition dates from the preceding or succeeding month. For the naming convention, the month is determined from where the midpoint Julian dates fall. For example, September monthly means may have been generated from images that were acquired in August or in October but the midpoint Julian date between the images falls within September. The exact dates used are included in the meta file.

2.3 Quality, Errors, and Limitations

2.3.1 Error Sources

Uncertainty in the velocity solution results from uncertainty in the match solution and uncertainty in image co-registration. Match solution uncertainty is estimated at each grid point from the sample of individual velocity solutions that results from the MIMC procedure. This error is typically on the order of one-third of a pixel. Co-registration error, the dominant source of uncertainty, is estimated from the residual velocities obtained over bedrock and very slow ice after the mean is removed. These errors vary considerably but are typically on the order of 100 m/year.

2.4 Instrumentation

2.4.1 Description

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) obtains high-resolution (15 to 90 square meters per pixel) images of the Earth in 14 different wavelengths of the electromagnetic spectrum, ranging from visible to thermal infrared light. ASTER was launched in December 1999 onboard Terra, the flagship satellite of NASA's Earth Observing System (EOS). For more information, see Terra | ASTER.

The Enhanced Thematic Mapper Plus (ETM+) instrument on board Landsat 7 is a fixed “whisk-broom,” eight-band, multispectral scanning radiometer capable of providing high-resolution imaging information of the Earth’s surface. Orbiting at an altitude of 705 km, the instrument detects spectrally-filtered radiation in visible near-infrared, short-wave near-infrared, long-wave near-infrared, and panchromatic bands from the sun-lit Earth in a 183 km wide swath.
Visit NASA Landsat Science | The Enhanced Thematic Mapper Plus for more information.

The Operational Land Imager (OLI) on Landsat 8 is an enhanced version of Landsat 7’s ETM+ that adds two new spectral bands: a deep blue visible channel (band 1) specifically designed for water resources and coastal zone investigation; and a new infrared channel (band 9) to detect of cirrus clouds. For more information, see USGS | Landsat 8.

3 SOFTWARE AND TOOLS

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

- Blue Marble Geographics Global Mapper
- QGIS
- GDAL
- Esri ArcGIS

4 RELATED DATA SETS

Greenland Ice Sheet Mapping Project (GIMP)

5 RELATED WEBSITES

MEaSUREs at NSIDC | Overview

6 CONTACTS AND ACKNOWLEDGMENTS

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7 REFERENCES

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8 DOCUMENT INFORMATION

8.1 Publication Date

March 2016

8.2 Date Last Updated

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