MEaSUREs Multi-year Greenland Ice Sheet Velocity Mosaic, Version 1

USER GUIDE

How to Cite These Data

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

Joughin, I., B. Smith, I. Howat, and T. Scambos. 2016. *MEaSUREs Multi-year Greenland Ice Sheet Velocity Mosaic, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/QUA5Q9SVMSJG. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0670

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This data set, part of the NASA Making Earth System Data Records for Use in Research Environments (MEaSUREs) program, contains a multi-year ice-sheet-wide velocity mosaic for Greenland derived from Interferometric Synthetic Aperture Radar (InSAR), Synthetic Aperture Radar (SAR), and Landsat 8 optical imagery data. The platform/sensor used as source data depends upon the year. Table 1 lists the primary data sources used in the mosaic.

Table 1. Data Sources and Temporal Coverage

Data Source	Temporal Coverage (Year)
RADARSAT 1 and 2 (Canadian Space Agency (CSA))	2000/2001 2005/2006 2006/2007 2007/2008 2008/2009 2012/2013
ALOS PALSAR (Japan Aerospace Exploration Agency (JAXA))	2007/2008 2008/2009 2009/2010 2010/2011
TerraSAR-X (TSX)/TanDEM-X (TDX) (German Aerospace Center (DLR))	2008-2015
ERS-1/2 tandem data (European Space Agency (ESA))	1995/1996
Landsat 8 (US Geological Society (GSA))	2014/2015

1.1 Parameters

This data set reports ice component velocities (v_x, v_y), defined by the polar stereographic grid, and velocity magnitude in m/year.

1.1.1 Sample Data Record

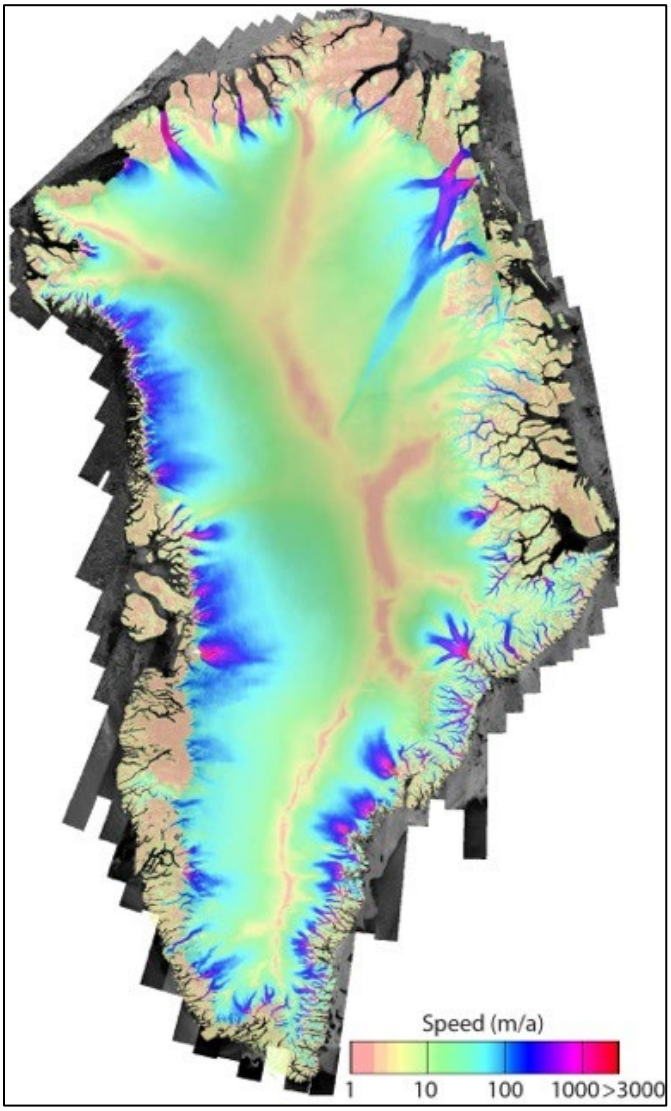

Figure 1. All Greenland Mosaic

1.2 File Information

1.2.1 Format

Data are available in GeoTIFF (`.tif`) and JPEG (`.jpg`) formats.

1.2.2 Directory Structure

The data set consists of the four GeoTIFF files and one JPEG listed below. See Table 2 for a description of the file name variables.

- greenland_vel_mosaic250_v1.jpg
- greenland_vel_mosaic250_vx_v1.tif
- greenland_vel_mosaic250_vy_v1.tif
- greenland_vel_mosaic250_ex_v1.tif
- greenland_vel_mosaic250_ey_v1.tif

Table 2. File Name Variables

Variable	Description
greenland_vel_mosaic250	Greenland 250 m velocity magnitude mosaic
vx *OR* vy	velocity x-direction OR velocity y-direction
ex *OR* ey	error x-direction OR error y-direction
v1	Version 1
ext	• .tif – GeoTIFF-formatted file • .jpg – JPEG-formatted file

1.3 Spatial Information

1.3.1 Coverage

This data set covers Greenland, bounded by the following coordinates:

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

1.3.2 Resolution

Data are sampled at 250 m.

1.3.3 Projection

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).

1.4 Temporal Information

1.4.1 Coverage

The data were collected between 1995 and 2015, as detailed in Table 1 above.

1.4.2 Resolution

The mosaic is an averaged representation of the period in which data were collected.

2 DATA ACQUISITION AND PROCESSING

2.1 Acquisition

The mosaic includes data from:

- CSA's RADARSAT 1 and 2 data from 2000/2001, 2005/2006, 2006/2007, 2007/2008, and 2008/2009, 2012/2013.
- JAXA's ALOS PALSAR data from 2007/2008, 2008/2009, 2009/2010, 2010/2011.
- DLR's TerraSAR-X (TSX)/TanDEM-X (TDX) data from 2008-2015.
- ESA's ERS-1/2 Tandem data from 1995/1996.
- USGS's Landsat 8 optical imagery data from 2014/2015.

The resulting mosaic represents an error weighted average of all the available source data at each point. See Figure 2 for examples of three of the data sources (Joughin, 2002). This averaging process means that at any given point, the resulting velocity estimate could be derived from a single image pair or more, and may represent an average of as many as dozens of pairs. As such, it is ***not*** a uniformly averaged velocity for the 20-year period. For slow moving regions in the interior where velocities are slowly changing, the mosaic should provide a reasonable approximation of velocity for the period. By contrast, for fast changing glaciers at the coast, the velocity may have fluctuated wildly over the 20-year period. For time series analysis of a basin, use the full suite of MEaSUREs products from the TerraSAR-X (NSIDC-0481) and Landsat velocity products (NSIDC-0646) for the most rapidly changing areas, the annual mosaics (NSIDC-0478) for the more slowly changing regions farther inland (Joughin et al., 2010), and this mosaic for the relatively constant interior.

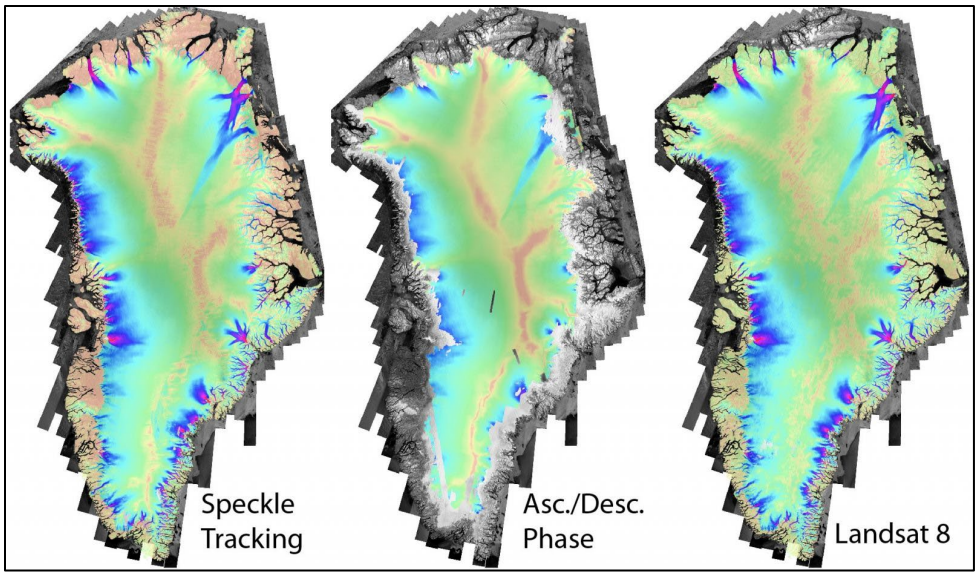

Figure 2. Three major sources of data used in producing the overall composite mosaic.

Much of the source data can be accessed individually through other MEaSUREs products: RADARSAT and ALOS (NSIDC-0478), LANDSAT (NSIDC-0646), and TerraSAR-X (NSIDC-0481). Due to limited data and success working with the data (i.e., poor interferometric correlation) in the high-accumulation Southeast region, some 1995/1996 ERS-1 and 2 data were used to obtain full coverage. Used in conjunction with the other data, these products improve the overall result. They are not of sufficient quality, however, to produce stand-alone products.

For much of the interior of the ice sheet, the crossing ascending (ALOS) and descending (RADARSAT-1) image pairs allowed velocity estimates entirely from the interferometric phase (Joughin et al., 1998). Because the errors for phase are much lower than for speckle-tracking, where they exist (Fig. 1), phase estimates are weighted the most heavily in the mosaicking process.

There are gaps in coverage, particularly in the southernmost regions of the ice sheet where coverage was often dropped in favor of other radar modes optimized for mapping sea ice in shipping lanes. As a result, the mosaic includes Landsat 8 data. The errors for Landsat generally are greater than for individual SAR estimates (speckle or phase), so the Landsat data are weighted less heavily than radar results.

Although the data are posted at 250 meters, the true resolution varies, depending on the data source. In most cases, the true resolution is closer to 500 meters. As a result, results near sharp velocity transitions may be biased. For example, velocities along the centerline of a narrow (< 1 km) glacier may read low because some nearby rock could be included when the resolution is 500-m.

2.2 Quality, Errors, and Limitations

2.2.1 Error Sources

Error estimates are provided for all velocity estimates in separate GeoTIFF files appended with _ex.tif and _ey.tif. In general, the errors maps represent the average behavior of the data, and errors could be much less than reported in some areas and much greater in others and care should be taken when assigning statistical significance based on the errors, especially given that the errors can be correlated over large areas. In the interior of the ice sheet where phase estimates are used, the reported errors are small (< 1 m/year). Comparison with control points suggest the errors are approaching but are not quite at this level, within a factor of 2; although with many cases, the errors agree closely with the estimates when slope effects are included.

The assumption of surface parallel flow means that there can be errors of up to about 3% due to errors in the slope data used to calculate velocity (Joughin, 2002b). These errors are not included in the formal error estimates. As a result, this error should be added in quadrature to the error map (i.e., Ex_total = sqrt(Ex_map)^2 + (0.03Vx^2).

Users should keep in mind that although the data have been screened carefully, errors well outside the formal estimates may exist, particularly in the Southeast where data quality is the poorest.

Interpolated Points

Small holes in the final maps have been filled via interpolation. These points can be identified as those which have valid velocity data but no corresponding error estimate. See Joughin, et al, 2002 for more detail on errors and how they were computed.

2.3 Instrumentation

2.3.1 Description

For additional information about the InSAR systems used to construct this data set, see the following web pages

- Canadian Space Agency's RADARSAT-1 and RADARSAT-2
- Japan Aerospace Exploration Agency's About ALOS - PALSAR
- DLR's TerraSAR-X and Tandem-X
- European Space Agency's ERS 1/2
- NASA's LANDSAT-8

3 SOFTWARE AND TOOLS

The `.tif` files can be viewed with a variety of Geographical Information System (GIS) software packages including QGIS and ArcGIS. The `.jpg` file is accessible with any image viewer

4 RELATED DATA SETS

Joughin, I., B. Smith, I. Howat, and T. Scambos. 2015. *MEaSUREs Greenland Ice Sheet Velocity Map from InSAR Data, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: http://dx.doi.org/10.5067/OC7B04ZM9G6Q. [Date Accessed].

Joughin, I., I. Howat, B. Smith, and T. Scambos. 2011, updated 2016. *MEaSUREs Greenland Ice Velocity: Selected Glacier Site Velocity Maps from InSAR, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi:http://dx.doi.org/10.5067/MEASURES/CRYOSPHERE/nsidc-0481.001. [Date Accessed].

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5 REFERENCES

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Rignot, E. and P. Kanagaratnam. 2006. Changes in the Velocity Structure of the Greenland Ice Sheet. *Science*, 311(5763): 986-990. doi: 10.1126/science.1121381.

6 DOCUMENT INFORMATION

6.1 Publication Date

August 2016

6.2 Date Last Updated

May 2025