# MEaSUREs Greenland Ice Velocity: Selected Glacier Site Velocity Maps from InSAR, Version 1

## USER GUIDE

**How to Cite These Data**

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

Joughin, I., I. Howat, B. Smith, and T. Scambos. 2011, updated 2019. *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. https://doi.org/10.5067/MEASURES/CRYOSPHERE/nsidc-0481.001. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0481

National Snow and Ice Data Center

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# 1 DATA DESCRIPTION

The investigators had some earlier problems processing data from the Jakobshavn Isbrae, Helheim, and Kangerdlugssuaq Glaciers, in part because the terminus was in a retreated position when the underlying DEM was created. Because of the slope discontinuity at the terminus, some artifacts exceeding the stated three percent error were observed. In 2015, WorldView imagery was used to extend the terminus forward and the data were reprocessed and re-released in January 2016. New data were also added at this time for the years 2009 – 2012.

## 1.1 Format

For each individual grid cell and time period, the velocity components (vx, vy) and corresponding error estimates (ex, ey) are provided in Geographic Tagged Image File Format (GeoTIFF). A JPEG image showing the magnitude of the velocity for the period is provided for easy visualization. An ASCII formatted metadata file containing source satellite acquistion information is also included.

## 1.2 File Naming Convention

This section explains the file naming convention used for this product with an example.

- **Example File Name:**
  - TSX_E61.10N_19Apr14_30Apr14_09-16-09_vx_v1.2.tif
  - TSX_E61.10N_19Apr14_30Apr14_09-16-09_vy_v1.2.tif
  - TSX_E61.10N_19Apr14_30Apr14_09-16-09_ex_v1.2.tif
  - TSX_E61.10N_19Apr14_30Apr14_09-16-09_ey_v1.2.tif
  - TSX_E61.10N_19Apr14_30Apr14_09-16-09_v1.2.jpg
  - TSX_E61.10N_19Apr14_30Apr14_09-16-09_v1.2.meta
- **Naming Convention:**
  - TSX_[grid]_[startdate]_[enddate]_[hh-mm-ss]_[datum]_v1.2.[ext]

Refer to the following table for descriptions of the values in the file naming convention.

Table 1. File Naming Convention

| Variable | Description |
|---|---|
| TSX | Data Source<br>TSX: denotes the twin satellites TerraSAR-X / TanDEM-X (TSX / TDX) |
| grid | Grid is defined by the following:<br>E, W, or S: East, West, or South Coast<br>Latitude in degrees, minutes |
| startdate | Acquisition start date (DDMMMYY) |
| enddate | Acquisition end date (DDMMMYY) |
| hh-mm-ss | Nominal time for pair |
| datum | Component velocity or error estimate<br>vx: x component of velocity<br>vy: y component of velocity<br>ex: x component of error<br>ey: y component of error |
| v1.2 | Version 1.2 of the data set |
| .ext | File extensions:<br>.tif = GeoTIFF formatted file<br>.jpg = JPEG file; visualization of the magnitude of the velocity<br>.meta = ASCII text file; contains the Central Julian date and nominal time (HH:MM:SS) for the pair, the date for each image, production date, sensor combinations, and geographical information |

## 1.3 Spatial Coverage and Resolution

This data set contains velocity data for most of the outlet glaciers for the Greenland Ice Sheet. It is organized into 55 study sites (grids). The spatial coverage map in Figure 1 shows the locations of all grids on a map of Greenland. A high resolution image of this map can be downloaded as a Portable Network Graphics (.png) file.

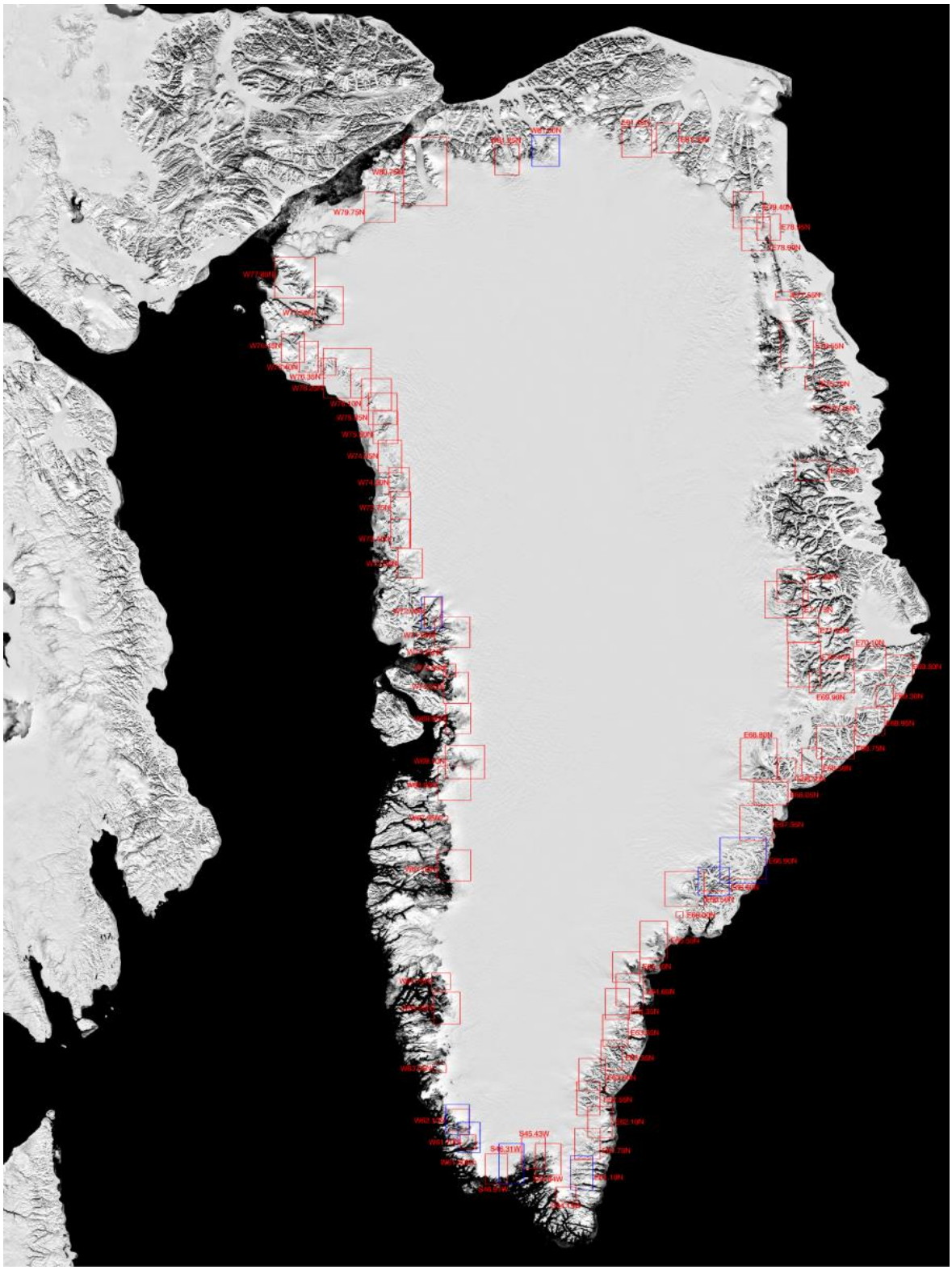

Figure 1. This map shows the locations of grids on a map of Greenland. Grids that were expanded in 2012 are shown in blue.

### 1.3.1 Spatial Resolution

100 meters

### 1.3.2 Projection

Data are provided in subregions of a polar stereographic grid with a standard latitude of 70° N and a 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.

The origin specifies the polar stereographic coordinates for the center of the lower left pixel, i.e., the first sample in the file. This specification, using the middle of the reference pixel, differs from that used in some GeoTIFF and other formats where the reference coordinates are specified for the outer corner of the reference pixel.

## 1.4 Temporal Coverage and Resolution

Start date: 01 January 2009 (ongoing)

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

### 1.4.1 Temporal Resolution

The temporal resolution varies between 11, 22, and 33 days on an 11-day repeat cycle.

## 1.5 Parameter or Variable

The vx and vy files yield values of velocity in m/yr, in the x and y directions defined by the polar stereographic grid. The velocities are true values and not subject to the distance distortions present in a polar stereographic grid. In some areas, small holes have been filled via interpolation. Interpolated values are identifiable as the locations where velocity data are present but no error estimate exist. Radar-derived velocities are determined using a combination of conventional InSAR and speckle tracking techniques. See Joughin (2002) for more detail on errors and how they are computed.

# 2 SOFTWARE AND TOOLS

GeoTIFF files can be viewed with a variety of Geographical Information System (GIS) software packages, including QGIS and ArcGIS.

# 3 DATA ACQUISITION AND PROCESSING

## 3.1 Theory of Measurements

The velocity maps in this data set were created using SAR data from DLR's twin satellites TerraSAR-X / TanDEM-X. The methods include a combination of speckle tracking and conventional interferometry. See Joughin (2002) for more detail.

## 3.2 Sensor or Instrument Description

This data set was produced using Synthetic Aperture Radar (SAR) data obtained by DLR's twin satellites TerraSAR-X / TanDEM-X, which fly in close formation only a few hundred meters apart.

### 3.2.1 Error Sources

Error estimates are provided for all non-interpolated, radar-derived velocity components (vx, vy). They include the statistical uncertainty associated with the phase and speckle tracking error inherent in the SAR data. Formal errors agree reasonably well compared with errors determined from GPS data (Joughin, 2002). However, the true uncertainty is likely larger and these estimates should be used as an indication of relative quality rather than as absolute error.

### 3.2.2 Version History

Version 1.2 was released in May 2017. Refer to Table 4 for the data set version history:

Table 2. Version History

| Version | Description |
|---|---|
| V1.2 (May 2017) | Renamed files to include the nominal time for pair; added 3 TSX subdirectories missing from their respective region directories; removed extraneous files from several TSX subdirectories; included .meta files for metadata |
| V1.1 (Feb. 2016) | GeoTIFF file format added; binary format discontinued; contains improved temporal sampling for the Jakobshavn Isbrae, Helheim, and Kangerdlugssuaq glaciers. The improved sampling addresses previous artifacts related to slope discontinuities at these glaciers' termini for the years 2009 – 2016 |
| V1 (May 2011) | Initial release |

# 4 REFERENCES AND RELATED PUBLICATIONS

Yushin Ahn, & Howat, I. M. (2011). Efficient Automated Glacier Surface Velocity Measurement From Repeat Images Using Multi-Image/Multichip and Null Exclusion Feature Tracking. IEEE Transactions on Geoscience and Remote Sensing, 49(8), 2838–2846. https://doi.org/10.1109/tgrs.2011.2114891

Howat, I. M., Box, J. E., Ahn, Y., Herrington, A., & McFadden, E. M. (2010). Seasonal variability in the dynamics of marine-terminating outlet glaciers in Greenland. Journal of Glaciology, 56(198), 601–613. https://doi.org/10.3189/002214310793146232

Joughin, I. (2002). Ice-sheet velocity mapping: a combined interferometric and speckle-tracking approach. Annals of Glaciology, 34, 195–201. https://doi.org/10.3189/172756402781817978

Joughin, I., Abdalati, W., & Fahnestock, M. (2004). Large fluctuations in speed on Greenland's Jakobshavn Isbræ glacier. Nature, 432(7017), 608–610. https://doi.org/10.1038/nature03130

Joughin, I., Smith, B. E., Howat, I. M., Scambos, T., & Moon, T. (2010). Greenland flow variability from ice-sheet-wide velocity mapping. Journal of Glaciology, 56(197), 415–430. https://doi.org/10.3189/002214310792447734

Joughin, I., Kwok, R., & Fahnestock, M. (1996). Estimation of ice-sheet motion using satellite radar interferometry: method and error analysis with application to Humboldt Glacier, Greenland. Journal of Glaciology, 42(142), 564–575. https://doi.org/10.3189/s0022143000003543

## 4.1 Related Data Sets

- MEaSUREs Greenland Ice Sheet Velocity Map from InSAR Data

## 4.2 Related Websites

- MEaSUREs at NSIDC | Overview
- NASA MEaSUREs Projects

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# 6 DOCUMENT INFORMATION

## 6.1 Publication Date

May 2011

## 6.2 Date Last Updated

July 2019