MEaSUREs InSAR-Based Antarctica Ice Velocity Map, Version 1

USER GUIDE

How to Cite These Data

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

Rignot, E., J. Mouginot, and B. Scheuchl. 2011. *MEaSUREs InSAR-Based Antarctica Ice Velocity Map, 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-0484.001. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/nsidc-0484/versions/1

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION 2
1.1 Format 2
1.2 File and Directory Structure 2
1.3 File Naming Convention 2
1.4 File Size 2
1.5 Spatial Coverage 2
1.5.1 Spatial Resolution 3
1.5.2 Projection and Grid Description 3
1.6 Temporal Coverage 3
1.7 Parameter or Variable 4
1.7.1 Variable Description 4
1.7.2 Sample Image 5
2 SOFTWARE AND TOOLS 5
2.1 Software and Tools 5
2.2 Volume 5
2.3 Quality Assessment 6
3 DATA ACQUISITION AND PROCESSING 7
3.1 Theory of Measurements 7
3.2 Data Acquisition Methods 8
3.3 Data Sources 8
3.3.1 Version History 10
4 REFERENCES AND RELATED PUBLICATIONS 10
4.1 Related Websites 11
5 CONTACTS AND ACKNOWLEDGMENTS 11
5.1 Acknowledgments: 11
6 DOCUMENT INFORMATION 12
6.1 Publication Date 12
6.2 Date Last Updated 12

1 DETAILED DATA DESCRIPTION

1.1 Format

Data are available in Network Common Data Form, Version 3 (NetCDF 3) format. For more information about working with NetCDF formatted data, visit the UCAR Unidata Network Common Data Form website.

1.2 File and Directory Structure

Data are available on the HTTPS site in the https://n5eil01u.ecs.nsidc.org/MEASURES/NSIDC-0484.001/ directory.

1.3 File Naming Convention

This section explains the file naming convention used for this data set. Two files are available:

antarctica_ice_velocity_450m.nc (450 m spacing)
antarctica_ice_velocity_900m.nc (900 m spacing)

1.4 File Size

The 450 m velocity file is approximately 1.4 GB. The 900 m file is approximately 340 MB.

1.5 Spatial Coverage

The data set spans the continent of Antarctica.

Southernmost Latitude: 90°S
Northernmost Latitude: 60°S
Westernmost Longitude: 180°W
Easternmost Longitude: 180°E

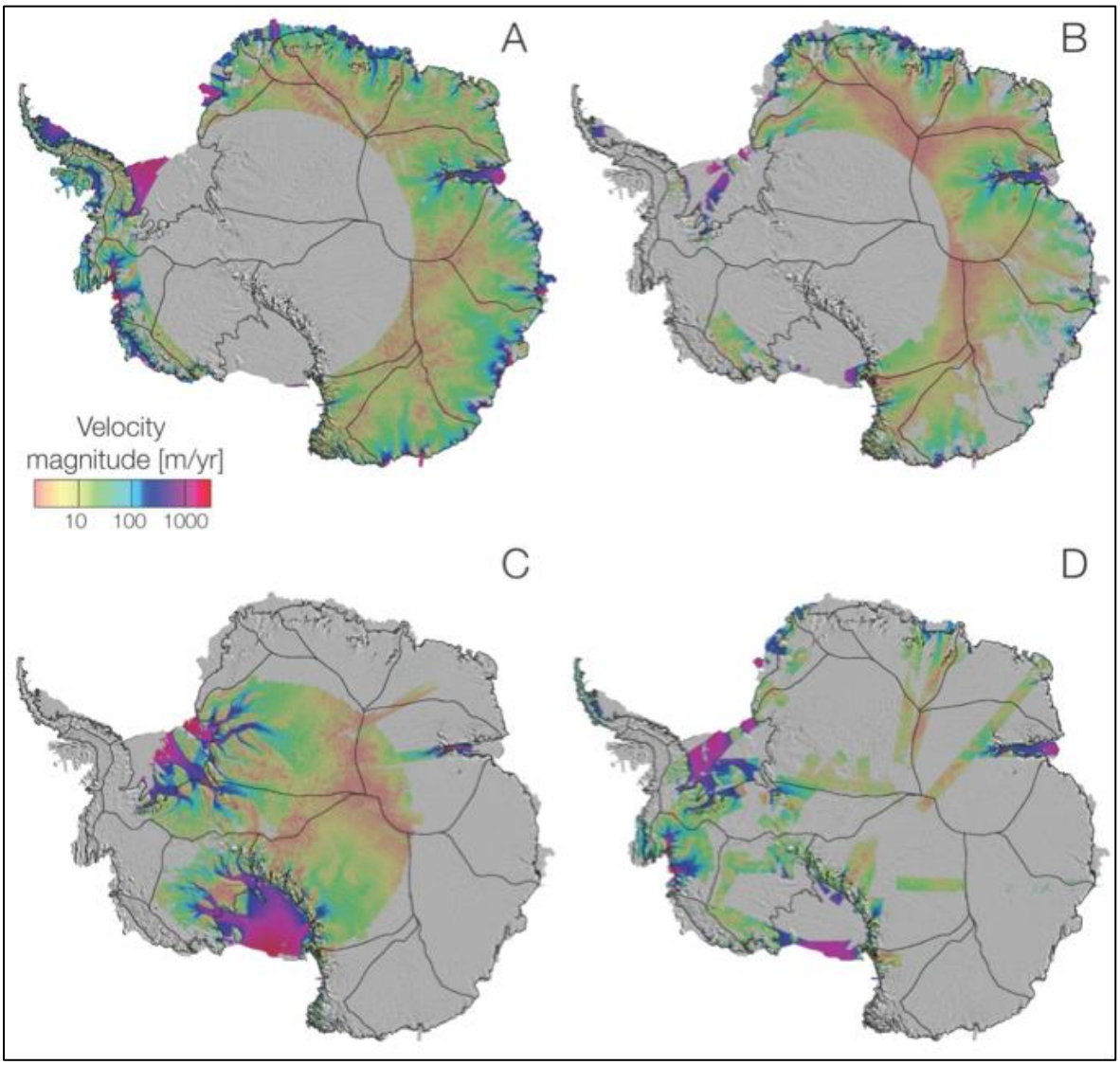

Figure 1. Antarctic ice velocity derived from (A) PALSAR, (B) ASAR, (C) RADARSAT-2, and (D) RADARSAT-1 and ERS-1 and 2 satellite radar interferometry color coded on a logarithmic scale and overlaid on a MODIS mosaic of Antarctica Projection is polar stereographic at 71°S secant plane. Thick black lines delineate major ice divides. (Rignot, Mouginot, and Scheuchl 2011)

1.5.1 Spatial Resolution

The velocity maps are provided at 450 m and 900 m spacings.

1.5.2 Projection and Grid Description

Polar stereographic with true scale at 71° S.

1.6 Temporal Coverage

The data used in this data set were collected between 1996 and 2011. Detailed information is provided in Section 33 below.

1.7 Parameter or Variable

These maps provide velocity data for the Antarctic Ice Sheet at 450 m and 900 m spacings. Velocity information (meters per year) for the x and y direction, as defined by the polar stereographic grid, is stored in the NetCDF variables named vx and vy. Error estimates for the velocity magnitude are located in the variable err; however, these values should be used more as an indication of relative quality rather than absolute error. More information about the error estimates is provided in Section 2.3 below as well as in Rignot et al. (2011).

1.7.1 Variable Description

Each NetCDF file contains the variables listed in Table 1:

Table 1. Variable Description

Variable	Description	Dimensions	Data Type
vx	Velocity in m/year in x direction	450 m: 12445 x 12445 900 m: 6223 x 6223	float
vy	Velocity in m/year in y direction	450 m: 12445 x 12445 900 m: 6223 x 6223	float
err	Estimated error in velocity magnitude	450 m: 12445 x 12445 900 m: 6223 x 6223	byte (signed)

To convert the vx and vy velocity components into magnitude (speed) and direction (angle), use the following equations:

(1) speed = √(vx2 + vy2)

(2) angle = arctan (vy / vx)

However, users should take care when computing the inverse tangent due to the function's inherent ambiguities. While the standard arctan function typically does not account for angles which differ by 180°, most modern computer languages and math software packages include the function ATAN2, which uses the signs of both vector components to place the angle in the proper quadrant.

1.7.2 Sample Image

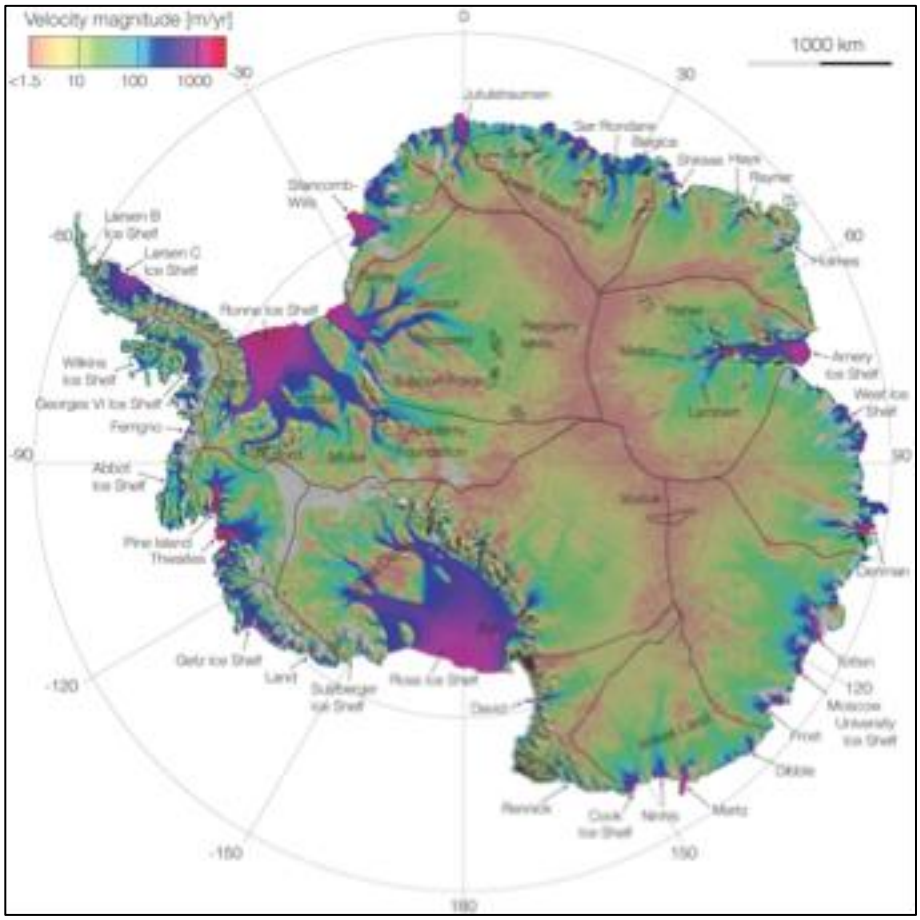

Figure 2. Antarctic ice velocity derived from ALOS PALSAR, Envisat ASAR, RADARSAT- 2 and ERS-1/2 satellite radar interferometry color coded on a logarithmic scale. (Rignot, Mouginot, and Scheuchl 2011)

2 SOFTWARE AND TOOLS

2.1 Software and Tools

Unidata at the University Corporation for Atmospheric Research maintains an extensive list of freely available Software for Manipulating or Displaying NetCDF Data.

2.2 Volume

Data volume

450 m spacing: 1.36 GB

900 m spacing: 340 MB

Total volume: 1.70 GB

2.3 Quality Assessment

A detailed description of these data and their quality is provided in Rignot, et al. (2011). The precision of ice flow mapping varies with the sensor, the geographic location, the technique of interferometric analysis (refer to Section 3 for details), the time period of analysis, the repeat cycle, and the amount of data stacking. The error estimates are summarized in Table 2. The error map in Figure 3 takes into account the following error sources:

- Error of speckle tracking and interferometric phase analysis respectively
- Errors caused by ionospheric perturbations (strongest in the azimuth direction, stronger in L-band compared to C-band, stronger in the East Antarctic Ice Sheet (EAIS) compared to the West Antarctic Ice Sheet (WAIS) because ionospheric perturbations are more abundant near the magnetic pole
- Data stacking (reduces the error noise as the square root of the number of interferometric pairs averaged)
- Respective weight of each instrument in the mosaicking

The total error is the square root of the sum of the independent errors squared. More details on the error estimates are provided in Rignot, et al., 2011 (supplementary online material). Table 2 provides the error in ice velocity mapping for each sensor, without data stacking, in range (Rg) and azimuth (Az).

Table 2. Error in Ice Velocity Mapping (m/yr)

Sensor	Repeat Cycle (day)	Pixel Size		Speckle Tracking		PhaseRg (m/yr)	IonosphereAz (m/yr)	Total Error (m/yr)
		Rg (m)	Az (m)	Rg (m/yr)	Az (m/yr)			
ALOS (WAIS)	46	4.7	3.3	0.5	0.2	0.03	17	17
ALOS (EAIS)	46	4.7	3.3	0.5	0.2	0.03	8	8
ASAR	35	4.7	3.3	1.6	0.3	0.03	4.1	4
RADARSAT-2	24	11.8	5.3	2.1	0.6	0.021	5.9	6
RADARSAT-1	24	8.1	5.3	2.4	0.6	0.03	5.9	6
ERS-1 and -2	1	7.9	4.0	56	12	0.73	N/A	1

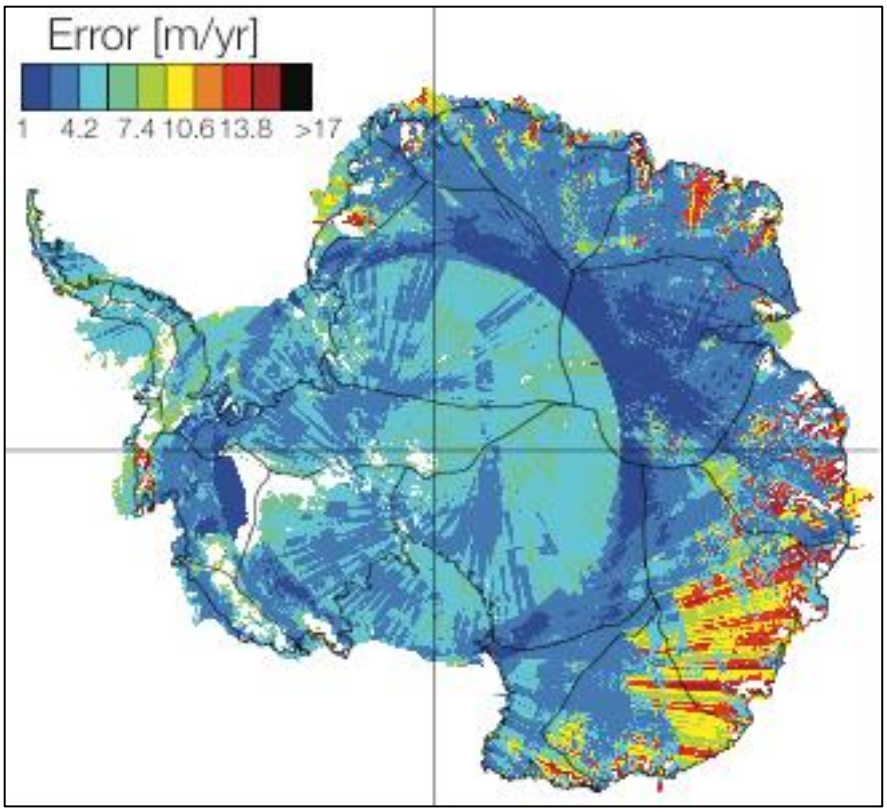

Figure 3. Velocity magnitude error on a linear scale color coded from 1 to greater than 16 m/yr. Thick black lines delineate major ice divides and the grounding line (Rignot, et al. 2011).

3 DATA ACQUISITION AND PROCESSING

3.1 Theory of Measurements

This data set provides ice velocity information for the entire Antarctic continent, derived from a variety of satellite radar interferometry data. Two techniques of interferometric analysis were used to generate the maps:

- Speckle tracking in both along (azimuth) and across (range) track directions
  Calculation of two-dimensional offsets in amplitude imagery
- Combinations of (range) interferometric phases along two independent tracks
  Combination of interferometric phases of two independent tracks to retrieve the surface flow vector

In both cases, surface parallel flow is assumed, a conventional approach for ice sheets.

3.2 Data Acquisition Methods

Ice velocity information for the Antarctic Ice Sheet was derived using satellite synthetic aperture radar interferometry (InSAR) data from spring 2009 data from the Canadian Space Agency (CSA)'s and MacDonald, Dettwiler and Associates Ltd. (MDA)'s RADARSAT-2, spring 2007-2008-2009 data from European Space Agency (ESA)'s Envisat Advanced Synthetic Aperture Radar (ASAR), and fall 2007-2008 data from the Japan Aerospace Exploration Agency (JAXA)'s Advanced Land Observing Satellite (ALOS) Phased Array type L-band Synthetic Aperture Radar (PALSAR), complemented by patches of CSA's RADARSAT-1 data from fall 2000 and ESA's Earth Remote Sensing Satellites ERS-1 and -2 data from spring 1996. Each radar instrument contributes its unique coverage and performance level. The final mosaics assemble 900 satellite tracks and more than 3,000 orbits of radar data. Data acquisitions between 2006 and 2011 were coordinated through the IPY Space Task Group.

The 450 m map contains some minor improvements compared with the 900 m product, such as slightly better coverage in West Antarctica due to the inclusion of a few additional tracks and a tide correction for Ross and Ronne ice shelves (RADARSAT-2, 2009 tracks only). Section 3.1 in the user guide of the MEaSUREs InSAR-Based Ice Velocity Maps of Central Antarctica: 1997 and 2009, Version 1 data set contains additional details about this correction.

3.3 Data Sources

Table 3 describes the data sources used in this data set.

Table 3.Temporal and spatial coverage of source satellite data

Platform	**Look Dir.**	**Mode**	**Repeat Cycle *(day)***	**Incidence Angle**	**Resolution *Rg x Az (m)***	**Swath *(km)***	**Frequency *(GHz)***	**# of Proc. Tracks**	**Raw Data Volume**	**Year**
ERS-1 & 2	Right	N/A	1-3	23	13x4	83	5.33	60	0.5	1996
RADARSAT-1	Left	S2-S7	24	28-47	12x5-17x6	62	5.33	72	0.5	1997
	Right	various	24	18-38	7x5-12x5	62	5.33	84	0.5	2000
ENVISAT	Right	IS2	35	23	13x5	70	5.33	115/130/210	1/1/2	2007/2008/2009
RADARSAT-2	Left	S5/EH4	24	41/57	12x5	70	5.33	135/14	4/1	2009/2011
ALOS PALSAR	Right	FBS	46	39	7x4	45	1.27	64/204/296	2/6/9	2006/2007/2008

3.3.1 Version History

Version 1.2 was released July, 2015. Refer to Table 4 for this data set's version history:

Table 4. Version History

Version	Description
V1.2	Binary data file format discontinued. Data available in NetCDF only (August, 2015).
V1.1	Added a second mosaic at 450 m resolution (September, 2013)
V1	Initial version (October, 2011)

4 REFERENCES AND RELATED PUBLICATIONS

Michel, R., and E. Rignot. 1999. Flow of Glacier Moreno, Argentina, from Repeat-Pass Shuttle Imaging Radar Images: Comparison of the Phase Correlation Method with Radar Interferometry. *J. Glaciol.* 45, 93100.

Rignot, E., S. Jacobs, J. Mouginot, and B. Scheuchl. 2013. Ice Shelf Melting Around Antarctica. *Science*, 341(6143): 266-270. doi:10.1126/science.1235798

Rignot, E., J. Mouginot, and B. Scheuchl. 2011. Ice Flow of the Antarctic Ice Sheet. *Science,* 333(6048): 1427-1430. doi:10.1126/science.1208336.

Rignot, E., J. Mouginot, and B. Scheuchl. 2011. Antarctic grounding line mapping from differential satellite radar interferometry. *Geophys*. Res. Lett., 38, L10504, doi:10.1029/2011GL047109.

Rignot, E., J. L. Bamber, M. R. Van Den Broeke, C. Davis, Y. H. Li, W. J. Van De Berg, & E. Van Meijgaard. 2008. Recent Antarctic ice mass loss from radar interferometry and regional climate modelling. *Nature Geoscience,* 1(2), 106-110. doi:10.1038/ngeo102

The following related documents are also available:

Table 5. Related Documents

Document	Description	URL
NASA MEaSUREs Data at NSIDC	NSIDC MEaSUREs Data Web site	http://nsidc.org/data/measures/index.html
NASA MEaSUREs	NASA MEaSUREs Projects Web site	http://earthdata.nasa.gov/our-community/community-data-system-programs/measures-projects

4.1 Related Websites

- MEaSUREs Antarctic Grounding Line from Differential Satellite Radar Interferometry
- MEaSUREs InSAR-Based Ice Velocity Maps of Central Antarctica: 1997 and 2009

5 CONTACTS AND ACKNOWLEDGMENTS

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RADARSAT-1, RADARSAT-2: Canadian Space Agency (CSA)

Data acquisitions between 2006 and 2011 are courtesy of the International Polar Year (IPY) Space Task Group.

6 DOCUMENT INFORMATION

6.1 Publication Date

October 2011

6.2 Date Last Updated

August 2015