MEaSUREs InSAR-Based Ice Velocity of the Amundsen Sea Embayment, Antarctica, 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. 2014. *MEaSUREs InSAR-Based Ice Velocity of the Amundsen Sea Embayment, Antarctica, 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-0545.001. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0545

National Snow and Ice Data Center

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION

1.1 Format

Data are provided in the following formats:

- Binary (big endian, IEEE floating point) with ENVI text header files
- Network Common Data Form (NetCDF), Version 3 (missing values represented by NaN)

1.2 File and Directory Structure

Data are available via HTTPS: https://n5eil01u.ecs.nsidc.org/MEASURES/NSIDC-0545.001/. Within this directory, there are ten folders for the years 1996, 2000, 2002, and 2006 through 2012, which contain the data files for that year. The 1996 folder contains additional geolocation files and a record spanning netcdf. Table 1 lists the files within these folders, where YYYY stands for the year the data were acquired.

Table 1. File Descriptions

File Name	Description
ASE_ice_velocity_1996-2012.nc	NetCDF (Version 3) file
ASE_ice_velocity_YYYY.dat	Dual band, band interleaved by pixel (BIP) binary data file with x and y velocities in m/year
ASE_ice_velocity_YYYY.hdr	ENVI header for the corresponding velocity .dat file
ASE_ice_velocity_YYYY_err.dat	Single band binary file with error estimates in m/year
ASE_ice_velocity_YYYY_err.hdr	ENVI header for corresponding error .dat file
ASE_ice_velocity_xaxis.dat	Single band binary file with distance (m) in x-direction (see Table 4)
ASE_ice_velocity_xaxis.hdr	ENVI header for xaxis.dat file
ASE_ice_velocity_yaxis.dat	Single band binary file with distance (m) in y-direction (see Table 4)
ASE_ice_velocity_yaxis.hdr	ENVI header for yaxis.dat file

See the section 1.3 for a description of the variables in the file names.

1.3 File Naming Convention

This section explains the file naming convention for this data set and includes example file names. Refer to Table 2 for descriptions of the values in the file naming convention.

Naming Convention:

ASE_ice_velocity_YYYY_v01.ext

Example File Names:

ASE_ice_velocity_2000_v01.dat

ASE_ice_velocity_2000_v01.hdr

Table 2. File Naming Convention

Variable	Description
ASE_ice_velocity	Amundsen Sea Embayment
YYYY	Year
err	Error estimates file
v01	Version number
.ext	File extension: .dat= binary data file .hdr=ENVI header file

1.4 File Size

The NetCDF file is approximately 444 MB. Individual velocity and error binary files are approximately 30 MB and 15 MB respectively.

1.5 Volume

The volume of this data set is 145 MB.

1.6 Spatial Coverage

These data lie within the following bounding box that spans the Amundsen Sea Embayment and West Antarctica, including Pine Island, Thwaites, Haynes, Pope, Smith, and Kohler glaciers:

- Northernmost Latitude: 73.3549° S
- Southernmost Latitude: 78.0137° S
- Easternmost Longitude: 82.8345° W
- Westernmost Longitude: 127.3826° W

Refer to Table 4 for additional information about each satellite's spatial and temporal coverage.

1.6.1 Spatial Resolution

450 m

1.6.2 Projection and Grid Description

Table 3. Geolocation Details

Projection	Polar Stereographic South
Description	Antarctic Polar Stereographic
Latitude of true origin	-90°
Standard parallel	-71°
Central meridian	0°
Scale Factor at central meridian	1
Datum	WGS 84
Ellipsoid	WGS 84
Units	meters
EPSG code	3031
PROJ4 description	+proj=stere +lat_0=-90 +lat_ts=-71 +lon_0=0 +k=1 +x_0=0 +y_0=0 +ellps=WGS84 +datum=WGS84 +units=m +no_defs
Reference	http://www.spatialreference.org/ref/epsg/3031/ https://nsidc.org/data/atlas/epsg_3031.html

Table 4. Grid Details

Number of rows	1707
Number of columns	2268
Units	meters
Grid cell x resolution (x-dimension of a pixel in map units)	450 m
Grid cell y resolution (y-dimension of a pixel in map units)	450 m
ulxmap – x-axis map coordinate of the center of the upper-left pixel	-1806625.0 m
ulymap – y-axis map coordinate of the center of the upper-left pixel. (YLLCORNER for ASCII data)	227125.0 m

1.7 Temporal Coverage

Data are available for the years 1996, 2000, 2002, and 2006 through 2012. Refer to Table 4 for additional information about each satellite's spatial and temporal coverage.

1.7.1 Temporal Resolution

Annual

1.8 Parameter or Variable

1.8.1 Parameter Description

These maps contain velocity data for the Amundsen Sea Embayment (ASE) and West Antarctica, including Pine Island, Thwaites, Haynes, Pope, Smith, and Kohler glaciers. Data are provided for the years 1996, 2000, 2002, and 2006 through 2012 at a spacing of 450 meters. Each data point provides the velocity (vx and vy respectively) in meters per year as defined by the polar stereographic grid. Error estimates for the velocity magnitude are also provided; however, these values should be interpreted as an indication of relative quality rather than absolute error. Refer to the 3.2.2 section of this document for more information.

Table 3 contains the names and descriptions of the variables in this data set. YYYY denotes the 4-digit year.

Table 5. Variable Names and Descriptions

Variable	Description	Dimensions (col x row)
vx[YYYY]	Velocity, m/year in the x-direction.	1707 x 2268
vy[YYYY]	Velocity, m/year in the y-direction.	1707 x 2268
err[YYYY]	Estimated error in velocity magnitude.	1707 x 2268
xaxis	Projected distance (m) to center of column from projection origin (South Pole)	1707 x 1
yaxis	Projected distance (m) to center of row from projection origin (South Pole)	1 x 2268

1.8.2 Sample Data Record

The following visualizations show data from MEaSUREs InSAR-based Ice Velocity of the Amundsen Sea Embayment, Antarctica overlaid on the MODIS Mosaic of Antarctica (MOA) Image Map:

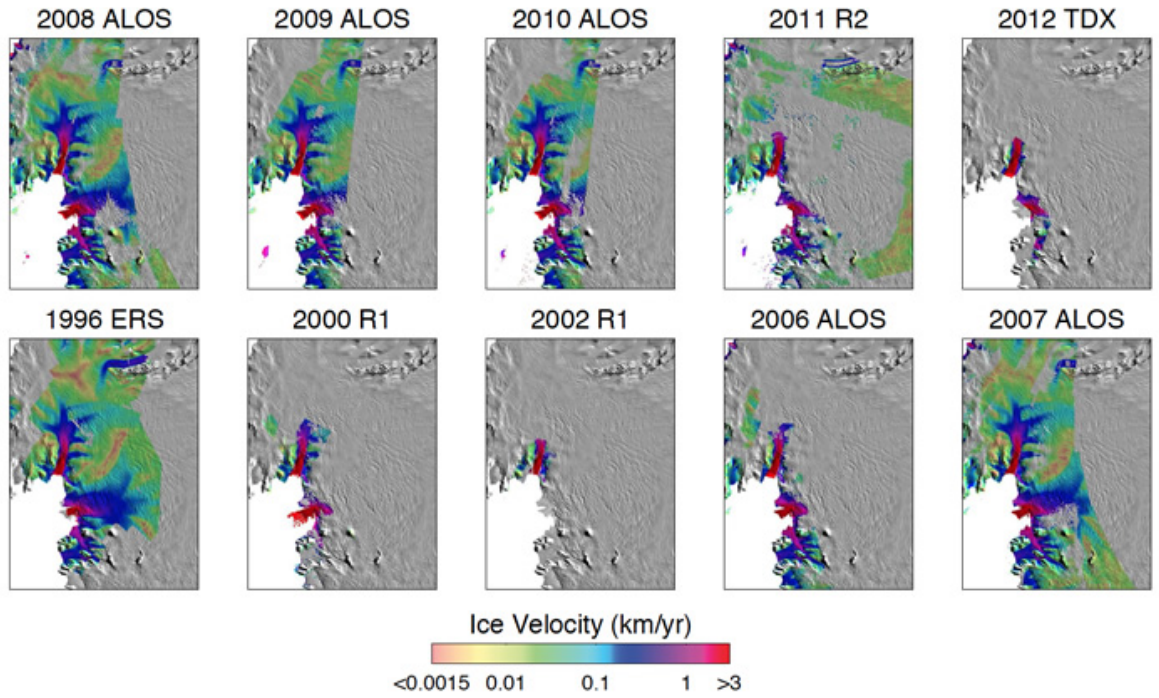

Figure 1. Satellite radar interferometry-based ice surface velocity maps for Amundsen Sea Embayment derived using data from ERS 1 (ERS), RADARSAT-1 (R1) in 2000 and 2002, ALOS PALSAR in 2006-2010, RADARSAT-2 (R2) in 2011, and TanDEM-X (TDX) in 2012. Velocities are overlaid on MOA and color coded on a logarithmic scale (Mouginot, J., E. Rignot, and B. Scheuchl, 2014).

2 SOFTWARE AND TOOLS

2.1 Software and Tools

Data are accessible using a variety of software packages. For more information about accessing NetCDF-formatted data, see NetCDF Resources at NSIDC.

3 DATA ACQUISITION AND PROCESSING

Table 6. Source Data Temporal and Spatial Coverage

Year	Sensor	Mode(s)	Incidence Angle(s), scene center	Rg[1] x Az[2] Spacing	# of Tracks	Comments
1996	ERS-1	n/a	23.4	8 x 4	25	Interferometry
2000	RADARSAT-1	Fine, Standard	28.2, 38.6, 44.5	5.4 x 8, 4.6 x 5.3, 11.6 x 5.1	5	Speckle tracking
2002	RADARSAT-1	Fine, Standard	28.2, 38.6, 44.5	5.4 x 8, 4.6 x 5.3, 11.6 x 5.1	2	Speckle tracking
2006	ALOS PALSAR	FBS[3]	39, 47.7	4.7 x 3.3	13	Speckle tracking
2007	ALOS PALSAR	FBS[3]	39.	4.7 x 3.3	30	Speckle tracking
2008	ALOS PALSAR	FBS[3]	39.	4.7 x 3.3	30	Speckle tracking
2009	ALOS PALSAR	FBS[3]	39.	4.7 x 3.3	22	Speckle tracking
2010	ALOS PALSAR	FBS[3]	39.	4.7 x 3.3	22	Speckle tracking
2011	RADARSAT-2	Standard	41.5	11.8 x 5.3	23	Speckle tracking
2012	TanDEM-X	n/a	46.3	1.4 x 1.8	7	Speckle tracking
[1]Range. [2]Azimuth. [3]Fine Beam Single Polarisation mode.						

3.1 Data Acquisition Methods

Ice velocities were derived from satellite synthetic aperture radar interferometry (InSAR) data obtained by the following international space agencies:

- The European Space Agency (ESA)
- The Canadian Space Agency
- The Japan Aerospace Exploration Agency (JAXA)
- The German Aerospace Center (DLR)

Data acquisitions between 2006 and 2012 were coordinated through the IPY Space Task Group.

3.2 Derivation Techniques and Algorithms

3.2.1 Processing Steps

These data were generated by using a speckle tracking technique. Refer to the work by Michel and Rignot, 1999 for more information. This was done to derive slant range and azimuth displacements from InSAR data (2000 and later) or interferometric phase analysis (1996). Assuming surface parallel flow, a digital elevation model was used to calculate the two-dimensional displacement field. The method is described in Rignot et al. 2011b and Mouginot et al. 2012. Where multiple data cycles were available for a given year, the resulting velocity products per track were combined to reduce data noise.

3.2.2 Error Sources

The precision of ice flow mapping varies with the geographic location, the technique used for interferometric analysis, the time period of analysis, the repeat cycle, and the amount of data stacking. Error estimates range from +/- 6m/year to +/- 20m/year, with ionospheric perturbations constituting the largest contribution. These estimates take 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)
- data stacking (reduces the error noise as the square root of the number of interferometric pairs averaged)

The total error is the square root of the sum of the independent errors squared. Additional details about the error estimation are provided in Rignot et al. (2011b) and Mouginot et al. (2012).

3.3 Sensor or Instrument Description

Velocity maps were derived from radar interferometry data obtained by several different satellite missions. See Table 4 for details.

4 REFERENCES AND RELATED PUBLICATIONS

Michel, R. and E. Rignot. 1999. Flow of Glaciar Moreno, Argentina, from Repeat-Pass Shuttle Imaging Radar Images: Comparison of the Phase Correlation Method with Radar Interferometry. *Journal of Glaciology* 45(149): 93-100.

Mouginot, J., E. Rignot, and B. Scheuchl. 2014. Sustained Increase in Ice Discharge from the Amundsen Sea Embayment, West Antarctica, from 1973 to 2013. *Geophysical Research Letters* 41(5): 1576–1584. doi: http://dx.doi.org/10.1002/2013GL059069

Mouginot, J., E. Rignot, and B. Scheuchl. 2012. Mapping of Ice Motion in Antarctica Using Interfero-Metric Synthetic-Aperture Radar Data. *Remote Sensing* 4(9): 2753-2767. doi: http://dx.doi.org/10.3390/rs4092753

Rignot, E., J. L. Bamber, M. R. Van Den Broeke, C. Davis, Y. H. Li, W. J. Van De Berg, and E. Van Meijgaard. 2008. Recent Antarctic Ice Mass Loss from Radar Interferometry and Regional Climate Modelling. *Nature Geoscience* 1(2): 106-110. doi: http://dx.doi.org/10.1038/ngeo102

Rignot, E., J. Mouginot, M. Morlighem, H. Seroussi, and B. Scheuchl. 2014. Widespread, Rapid Grounding Line Retreat of Pine Island, Thwaites, Smith, and Kohler Glaciers, West Antarctica, from 1992 to 2011. *Geophysical Research Letters* 41(10): 3502–3509. doi: http://dx.doi.org/10.1002/2014GL060140

Rignot, E., J. Mouginot, and B. Scheuchl. 2011a. Antarctic Grounding Line Mapping from Differential Satellite Radar Interferometry. *Geophysical Research Letters* 38(10): Art. #L10504. doi: http://dx.doi.org/10.1029/2011GL047109

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

Scheuchl, B., J. Mouginot, and E. Rignot. 2012. Ice velocity Changes in the Ross and Ronne Sectors Observed Using Satellite Radar Data from 1997 and 2009. *The Cryosphere 6*: 1019-1030. doi: http://dx.doi.org/10.5194/tc-6-1019-2012

4.1 Related Data Collections

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

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- RADARSAT-2: Canadian Space Agency (CSA), MacDonald, Dettwiler and Associates Ltd. (MDA). RADARSAT-2 acquisitions (2011) are courtesy of the IPY Space Task Group.
- TanDEM-X: German Aerospace Center (DLR)

ALOS PALSAR and RADARSAT-2 acquisitions were part of a multi-SAR-sensor effort to provide interferometric SAR coverage of the entire Antarctic continent during the International Polar Year (IPY). Data acquisitions are courtesy of the IPY Space Task Group. Post IPY acquisitions are being coordinated through the Polar Space Task Group.

6 DOCUMENT INFORMATION

6.1 Publication Date

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6.2 Date Last Updated

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