MEaSUREs Greenland Ice Mapping Project (GIMP) 2000 Image Mosaic, Version 1

USER GUIDE

How to Cite These Data

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

Howat, I. 2017, updated 2018. *MEaSUREs Greenland Ice Mapping Project (GIMP) 2000 Image Mosaic, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/4RNTRRE4JCYD. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0713

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

The parameter for this data set is ice sheet/glacier surface morphology.

1.1.1 Parameter Description

This data set provides a high-resolution image mosaic of the Greenland ice sheet that can be used for mapping and land surface classification.

The panchromatic (band 8) mosaic provides the highest-resolution view of the ice sheet surface (15 m), resolving topographic features, large crevasses, and other geophysical structures. The additional bands provided for each tile are useful for understanding surface properties during the spring-summer months, such as snow grain size, bedrock outcrops, mapping layering in the snow, and blue ice or lake filled regions.

NOTE: Users of GIMP DEM or GIMP 2000 Image Mosaic images may find it helpful to mask out areas outside of the Greenland coastline using the corresponding 15 m, 30 m, or 90 m ocean mask image from the MEaSUREs Greenland Ice Mapping Project (GIMP) Land Ice and Ocean Classification Mask, Version 1 data set. To apply the ocean mask, set the target mosaic image to the fill value (-9999) wherever the mask equals 1 (NSIDC has tested this approach).

1.2 File Information

1.2.1 Format

The data files are provided in GeoTIFF (.tif) format. The final image mosaic is composed of 36 tiles (see Figure 1), each of which encompasses a set of 12 files: nine image files for each Landsat 7 ETM+ band, two index images (one at 15 m and one at 30 m resolution; designated with _N_ in the file name), and one accompanying metadata file in ASCII text (.txt) format. Each pixel in the index image provides the identification number (scene ID) of its corresponding Landsat source image, which is also listed in the metadata file. In addition to the scene ID, the metadata file provides the source-image acquisition time and, if available, the root mean-square control point registration error (RMSE). For a more detailed description, see the file naming convention section, which describes the file names on the example of tile 0,5.

1.2.2 File Size

The image files (`.tif`) range from 2.5 to 266 MB. The index files (`*N.tif`) range from 2.2 to 2.4 MB. The metadata files (`.txt`) range from 1 to 2 KB.

The total data set volume is approximately 25.3 GB.

1.2.3 Naming Convention

The following tables explain the file naming convention for the mosaics included in this data set (on the example of tile 0,5). Table 1 provides the naming convention and example file names; Table 2 describes the variables used in the file naming convention.

Table 1. File Naming Convention

File Type	Naming Convention	Example File Names
Image Files	[tile_C_R]_mosaic_[RR]_band[B][_radarsat]_v1.1.ext	tile_0_5_mosaic_15m_band1_v1.1.tif tile_0_5_mosaic_15m_band2_v1.1.tif tile_0_5_mosaic_15m_band3_v1.1.tif tile_0_5_mosaic_15m_band4_v1.1.tif tile_0_5_mosaic_15m_band8_v1.1.tif tile_0_5_mosaic_15m_band8_radarsat_v1.1.tif tile_0_5_mosaic_30m_band5_v1.1.tif tile_0_5_mosaic_30m_band6_1_v1.1.tif* tile_0_5_mosaic_30m_band6_2_v1.1.tif* tile_0_5_mosaic_30m_band7_v1.1.tif
Index Files	[tile_C_R]_mosaic_[RR]_N_v1.1.ext	tile_0_5_mosaic_15m_N_v1.1.tif tile_0_5_mosaic_30m_N_v1.1.tif
Metadata File	[tile_C_R]_meta_v1.1.ext	tile_0_5_meta_v1.1.txt

*The naming convention is different for band 6 and includes the two gain settings: band6_1 (low gain), band6_2 (high gain).

Table 2. Naming Convention Description

String	Description
tile_C_R	Column and row of mosaic tile. Tile 0_0 is in the lower left corner, Tile 5_5 is in the upper right (see Figure 1)
mosaic	mosaic image file
RR	Resolution (15m or 30m)

String	Description
band[B]	Landsat 7 ETM+ band (1 through 8)
radarsat	RADARSAT-1 SAR data used in the mosaic for that tile (absent if not used)
N	Index image
meta	Metadata file containing each Landsat scene identification number (scene ID) used in the mosaic, acquisition time for that tile, and the root mean-square control point registration error where available.
v1.1	version 1.1
.ext	Filename extension (.tif for GeoTIFF file and .txt for metadata file)

1.3 Spatial Information

1.3.1 Coverage

The spatial coverage is:

Southernmost Latitude: 60° N
Northernmost Latitude: 82° N
Easternmost Longitude: 20° W
Westernmost Longitude: 70° W

1.3.2 Resolution

The spatial resolution is 15 m for bands 1, 2, 3, 4 and 8, and 30 m for bands 5, 6, 7.

1.3.3 Projection and Grid Description

Data are provided in standard NSIDC polar stereographic north grid (EPSG 3413) centered on Greenland.

The data are provided as a set of 36 tiles of 6 rows by 6 columns, numbered from 0-0 in the lower left corner to 5-5 in the upper right (see Figure 1). Each tile has dimensions of 249.3 km by 450 km. These dimensions were selected because they are divisible by 15 m, which is the resolution of Landsat-7 Enhanced Thematic Mapper Plus (ETM+) band-8 (panchromatic) imagery.

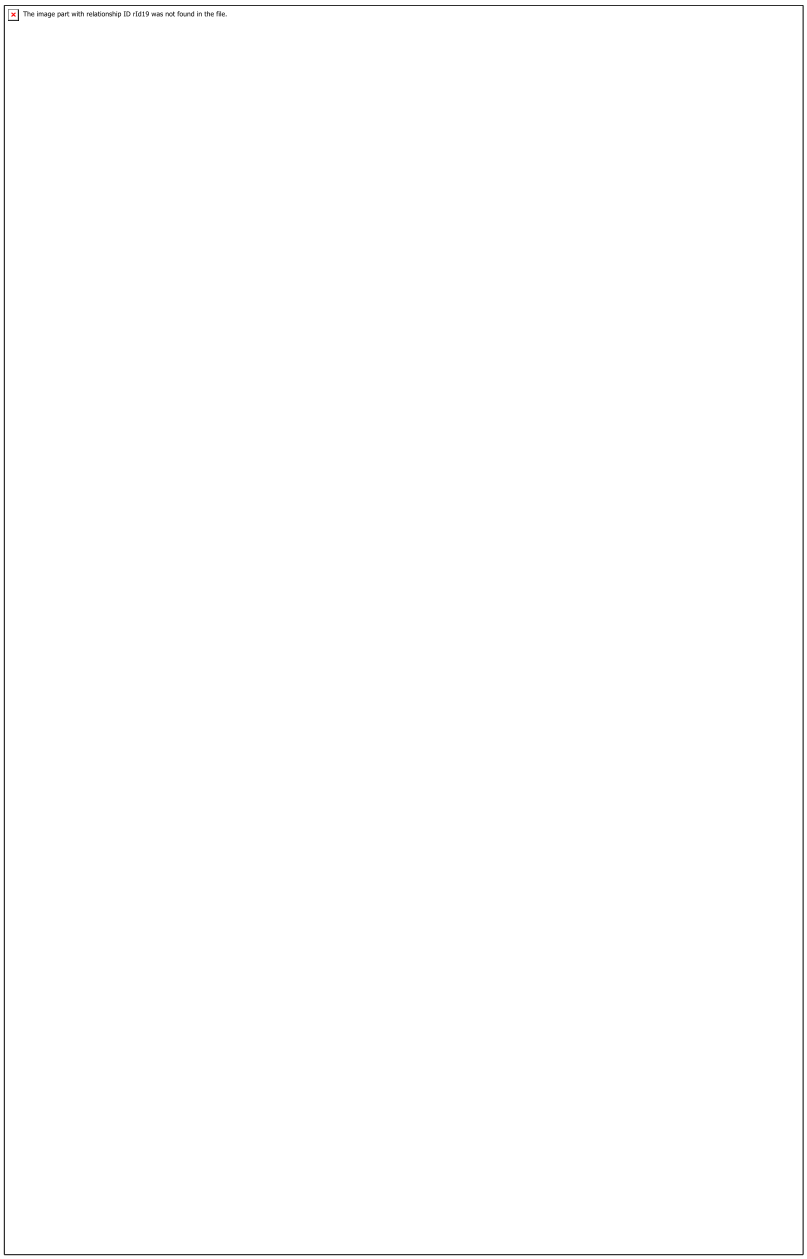

Figure 1. GIMP USGS's Landsat-7 ETM+ band-8 and CSA's RADARSAT-1 complete mosaic of Greenland with tile boundaries and tile numbers overlain. The map projection is polar stereographic (EPSG 3413).

1.4 Temporal Information

1.4.1 Coverage

30 June 1999 to 04 September 2002

1.4.2 Resolution

The temporal resolution is approximately three years.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The 15 m resolution image mosaic was created using USGS's Landsat 7 ETM+ and CSA's RADARSAT-1 SAR imagery. The methods include a combination of image cloud masking, pan sharpening, image sampling and resizing, and image coregistration. Please see Howat (2014) for more information regarding processing methods.

2.2 Acquisition

South of approximately 81.2° N, orthorectified Landsat 7 ETM+ imagery distributed by the USGS was used. Using 01 August 2000 as a target date, imagery was selected from July and August, as close in time as possible to 01 August for the years, in preferential order, of 2000, 1999, 2001 and 2002. North of the maximum extent of Landsat, the data include SAR amplitude imagery mosaics acquired between October and December 2000 by the CSA's RADARSAT-1 satellite. These data were produced by the Applied Physics Laboratory at the University of Washington as part of GIMP (Joughin et al., 2010).

2.3 Processing

For Landsat data, all imagery was filtered for clouds and visually inspected for quality. In order to increase the consistency of the grayscale between images, each digital number image was converted to reflectance, including corrections for sun angle and distance using the parameters provided in the metadata. Multispectral bands 1 through 4 were pan-sharpened to 15 m posting using band-8 and a simple and fast additive method in which the band-8 image was down-sampled to 30 m and differenced from each multispectral band. The difference image was then up-sampled to 15 m using bilinear interpolation and added to the band-8 image. The pan-sharpened reflectance images were re-gridded using cubic convolution and mosaicked to the reference grid. Where images overlapped, the pixel that was closest in time to the target date of 1 August 2000 was selected. The mosaicked images were converted back to a byte-precision digital number by linearly scaling the reflectance values to the global minimum and maximum for each band.

The SAR data are distributed at 20 m resolution. Data were up-sampled through bilinear interpolation to 15 m to match the resolution of Landsat band-8.

The RADARSAT and Landsat band-8 imagery were merged by applying a stretch to the RADARSAT image so that the histograms of both data sets matched where they overlapped.

The final image mosaic is distributed in 249.3 to 250 km tiles. These dimensions were selected because they are divisible by 15 m, which is the resolution of USGS's Landsat-7 Enhanced Thematic Mapper Plus (ETM+) band-8 (panchromatic) imagery. Each tile has one image for each band, plus an index image in which each pixel gives the index number of its corresponding source image in an accompanying metadata file. The metadata file lists each Landsat scene identification number (scene ID) used in the mosaic for that tile, the acquisition time and the root-mean-square control point registration error where available. The original scene ID, acquisition date and geolocation error for any pixel in an image can be obtained using the index image.

Please see Howat (2014) for more information regarding processing methods.

2.4 Quality, Errors, and Limitations

2.4.1 Error Estimates

The USGS employs two levels of geo-registration processing for their imagery (see https://www.usgs.gov/core-science-systems/nli/landsat/landsat-levels-processing). First, Standard Terrain Correction (Level 1T) incorporates both ground control points and a DEM for terrain corrections. Geodetic accuracy depends on the accuracy of the ground control and the quality of the DEM and is better than 90 m. Imagery covering the periphery and margin of the ice sheet, where features are visible on the surface, are processed to L1T. For L1T imagery, the root mean square of the residual between the geolocation model and the ground control are provided in the imagery metadata and are typically several meters. Second, Systematic Correction (Level 1G) uses only the satellite ephemeris for geolocation, providing a 1σ geometric accuracy within 250 m. Scenes over the featureless interior of the ice sheet are typically processed to L1G. As with USGS's Landsat, the primary source of geolocation error in the CSA's RADARSAT imagery is error in the DEM used for terrain correction and these errors are similar in magnitude to the Landsat mosaic (Moon and Joughin, 2008).

2.4.2 Quality Assessment

Please see Howat (2014) for more information regarding the quality and processing methods used to produce this data set.

2.5 Instrumentation

2.5.1 Description

This data set was produced from images acquired by the Landsat 7 Enhanced Thematic Mapper Plus (ETM+) and Synthetic Aperture Radar (SAR) from the RADARSAT-1 satellite.

3 SOFTWARE AND TOOLS

A variety of Geographical Information System (GIS) software packages will work with GeoTIFF files, including ArcGIS, ENVI, GDAL, and QGIS.

4 VERSION HISTORY

Version 1.1 was released April 2017. Refer to Table 3 for this data set's version history:

Table 3. Version History

Version	Description
V1.1	This version corrects the location of the upper left pixel in each GeoTIFF file. The previous version incorrectly specified the location of the upper left pixel as the distance in meters from the north pole to the center of the upper left pixel. The corrected location of the upper left pixel is the distance in meters from the north pole to the upper left corner of the upper left pixel. This correction effectively shifted the location by one-half pixel to the upper left relative to their positions in the previous version. Only the geolocation metadata in each GeoTIFF have changed; the data array is the same as in the previous version.
V1	Initial version (February 2017)

5 RELATED DATA SETS

Greenland Ice Mapping Project (GIMP)
MEaSUREs Greenland Ice Mapping Project (GIMP) Land Ice and Ocean Classification Mask, Version 1

6 RELATED WEBSITES

Byrd Polar Research Center Glacier Dynamics Research Group
MEaSUREs Data | Overview
USGS Landsat Missions

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Acknowledgements:

These data were generated through a grant from the NASA Making Earth System Data Records for Use in Research Environments MEaSUREs Program.

8 REFERENCES

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Joughin, I., B. E. Smith, I. M. Howat, T. Scambos, and T. Moon. 2010. Greenland flow variability from ice-sheet-wide velocity map- ping. *Journal of Glaciology* 56: 415–430.

Moon, T. and I. Joughin. 2008. Changes in ice front position on Greenland's outlet glaciers from 1992 to 2007. *Journal of Geophysical Research - Earth Surface* 13(2): Art. #F02022. doi: 10.1029/2007JF000927.

9 DOCUMENT INFORMATION

9.1 Publication Date

February 2017

9.2 Date Last Updated

29 December 2020