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

USER GUIDE

How to Cite These Data

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

Howat, I. 2017. *MEaSUREs Greenland Ice Mapping Project (GIMP) Land Ice and Ocean Classification Mask, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/B8X58MQBFUPA [Date Accessed].

We also request that you acknowledge the author(s) of this data set by referencing the following peer-reviewed publication:

Howat, I., A. Negrete, and B. Smith. 2014. The Greenland Ice Mapping Project (GIMP) land classification and surface elevation data sets. *The Cryosphere*, 8. 1509-1518. https://doi.org/10.5194/tc-8-1509-2014

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0714

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This data set provides complete land ice and ocean classification masks posted at 15-m, 30-m and 90-m for the Greenland ice sheet. Ice cover was mapped using a combination of orthorectified panchromatic (band-8) imagery from the Landsat 7 Enhanced Thematic Mapper Plus (ETM+), distributed by the US Geological Society (USGS), and the Canadian Space Agency's (CSA) RADARSAT-1 Synthetic Aperture Radar (SAR) amplitude images. The Landsat imagery was acquired for the months of July through September in 1999, 2000 and 2001 (mostly 2000) and the RADARSAT imagery was acquired in fall of 2000.

1.1 Parameters

The parameter provided is Land Ice/Ocean Classification. Depending upon the specific mask, the data values (0 or 1) indicate glacier ice or ocean and all other terrain.

Note: The Grounded Ice mask has ‘1’ and ‘NoData’ values, whereas the Ocean and Ice masks have ‘0’ and ‘1’ values.

1.2 File Information

1.2.1 Format

Data are available in GeoTIFF (`.tif`) format.

The 15 and 30 m resolution masks are distributed as sets of 36 tiles, as shown in Figure 1. Additionally, a complete 90 m resolution ice-sheet-wide mask is also provided, and is comprised of the following: a grounded ice mask, an ice mask, and an ocean mask.

1.2.2 Naming Convention

The following tables explain the file naming convention for the mosaics included in this data set. See Table 1 for an explanation of the variables for file names for the 15 m and 30 m files and Table 2 for the 90 m files.

For the 15 and 30 m resolution masks, there are 72 files for each: one GeoTIFF for the land ice mask and one GeoTIFF for the ocean mask for each of the 36 tiles. They are named according to the convention below:

```
Gimp[Ice/Ocean]Mask_[RR]m_tile[C_R]_v1.1.ext
```

Example File Names for 15 m and 30 m for tile 0_5:

- GimpIceMask_15m_tile0_5_v1.1.tif
- GimpOceanMask_15m_tile0_5_v1.1.tif
- GimpIceMask_30m_tile0_5_v1.1.tif
- GimpOceanMask_30m_tile0_5_v1.1.tif

Table 1. Naming Convention Description for 15 m and 30 m files

String	Description
Gimp	Greenland Ice Mapping Project
[Ice/Ocean]Mask	IceMask indicates glacier ice, OceanMask indicates ocean and all other terrain
[RR]m	Resolution (15m or 30m)
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)
v1.1	version 1.1
.tif	File name extension for GeoTIFF-formatted file

For the 90 m files, the naming convention is as follows:

Gimp[GroundedIce/Ice/Ocean]Mask_[RR]m_v1.1.ext

File Names for 90 m:

- GimpGroundedIceMask_90m_v1.1.tif
- GimpIceMask_90m_v1.1.tif
- GimpOceanMask_90m_v1.1.tif

Table 2. Naming Convention Description for 90 m files

String	Description
Gimp	Greenland Ice Mapping Project
[GroundedIce/Ice/Ocean]Mask	GroundedIceMask indicates crounded glacier ice; IceMask indicates glacier ice, OceanMask indicates ocean and all other terrain
[RR]m	Resolution (90m)
v1.1	version 1.1
.tif	File name extension for GeoTIFF-formatted file

1.3 Spatial Information

1.3.1 Coverage

Southernmost Latitude: 60° N

Northernmost Latitude: 82° N

Easternmost Longitude: 20° W

Westernmost Longitude: 70° W

1.3.2 Resolution

The data are available in 15 m, 30 m, or 90 m resolutions.

1.3.3 Projection and Grid Description

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

The 15 m and 30 m masks are provided as sets 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 by 450 km. 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+) panchromatic (band-8) imagery.

Please note that there is a projection issue with the `GimpGroundedIceMask_90m_v1.1.tif` file. The data are not in the standard NSIDC polar stereographic north grid due to a small error in the header information; the latitude of origin was set to '7' when it should be '70'. This is planned to be corrected for in a future version of the data set. In the meantime, the user can reproject this file using the following GDAL command:

```
gdalwarp -s_srs EPSG:3413 -t_srs EPSG:3413 GimpGroundedIceMask_90m_v1.1.tif output.tif
```

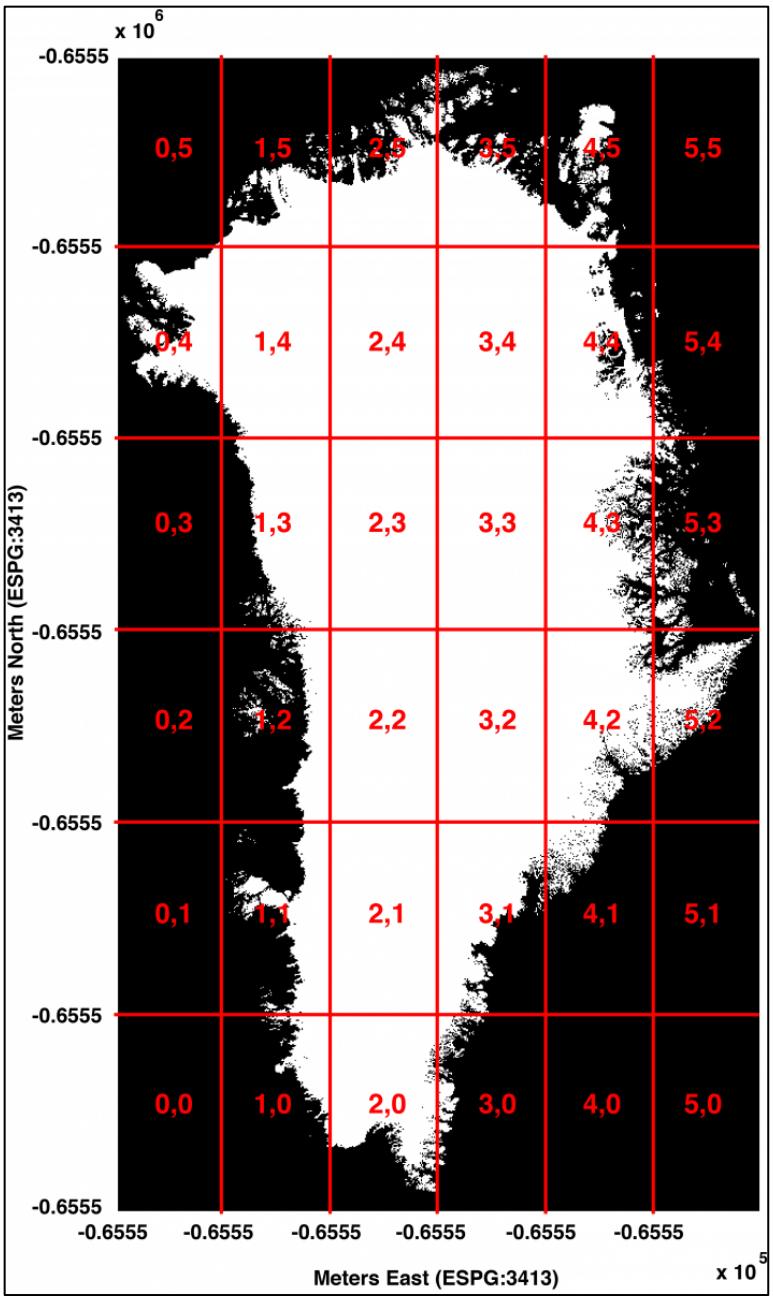

Figure 1. GIMP Landsat-7 ETM+ band-8 and RADARSAT-1 ice mask (90 m resolution) of Greenland with tile boundaries and tile numbers overlain. The map projection is polar stereographic (EPSG 3413).

1.4 Temporal Information

1.4.1 Coverage

These data cover the period from 1999 through 2001. See Data Acquisition Methods below for details.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Land classification masks provide a method of co-registration of repeat imagery and elevation data to track changes of the ice surface, which can change with time, while areas of exposed bedrock provide a control for measuring the changes. In addition, masks provide an accurate delineation of ice boundaries, which become a benchmark for measuring future ice margin changes. Landsat-7 ETM+ data are commonly used for mapping snow and ice.

2.2 Instrumentation

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

2.3 Data Acquisition Methods

The mask files included in this data set were derived from the GIMP 2000 Image Mosaic, created using Landsat 7 ETM+ and RADARSAT-1 SAR imagery. The Landsat imagery was acquired for the months of July through September in 1999, 2000 and 2001 (mostly 2000) and the RADARSAT imagery was acquired in fall of 2000.

2.4 Processing Steps

The mask files included in this data set were created from manual digitization of the panchromatic and pan-sharpened multispectral GIMP 2000 Image Mosaic. Using manual methods, the ice margin can be difficult to locate visually in areas of abundant debris and snow cover. Margins of debris-covered ice were identified by breaks in surface slope, emerging melt water streams, color differences and the presence of small melt water ponds typical of debris-covered glaciers. Similarly, glaciers were differentiated from perennial snowfields by visible crevassing, surface moraines and the existence of a visible toe. Snowfields without these features were not classified as glaciers. Using the same method, the coastline is digitized to produce an ocean mask, with the null of the ice and ocean masks being ice-free terrain (Howat, et al., 2014). Please see Howat et al., 2014 for more information regarding processing methods.

2.5 Error Estimates

Uncertainty in these classification masks arise from three sources of error: (1) image pixel resolution, (2) image geo-registration and (3) erroneous selection or non-selection of pixels (i.e.,

mapping error). All error sources are expected to vary randomly in space. However, there is likely a systematic component of error source (2) over distances equivalent to the size of a single image (e.g., 185 km for Landsat 7). This is due to errors in the registration model used to orthorectify the image, which typically is ±5 m, or one third of a pixel for L1T-processed imagery.

Error source (1) contributes a random error of one pixel for each ice boundary pixel. The position of any point of the ice margin has an uncertainty of 21 m while the total error for a given area of ice is then (8N)1/2x2, where N is the number of boundary pixels and x is the pixel posting in meters. Erroneous selection or non-selection of pixels (error source 3) can be due to debris cover, shadows and misidentification by the operator, as well as the ambiguity of delineating an ice boundary at glacier fronts ending in packs of icebergs. Without ground control, delineation of the ice edge in areas of debris cover, terminal moraines and persistent snow cover is subjective. These errors are difficult to quantify. Due to ambiguity in the ice edge and operator error, estimations were done by comparing mappings performed by three different operators over the same area. On average, each operator identified 24.21 km (1614 pixels) of ice margin over the common area, with a 660 m (44 pixels) difference between the maximum and minimum mappings, giving an estimated error of ±3 percent. This error, however, is expected to vary widely by particular location and size of area considered (Howat et al., 2014).

2.6 Quality Assessment

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

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 Summary

Version	Release Date	Description of Changes
V1	February 2017	Initial release
V1.1	April 2017	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 has changed; the data array is the same as in the previous version.

5 RELATED DATA SETS

Greenland Ice Mapping Project (GIMP)

6 RELATED WEBSITES

Byrd Polar Research Center Glacier Dynamics Research Group

MEaSUREs Data | Overview

Alaska Satellite Facility

Canadian Space Agency

7 CONTACTS AND ACKNOWLEDGMENTS

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8 REFERENCES

Howat, I. M., A. Negrete, and B. E. Smith. 2014. The Greenland Ice Mapping Project (GIMP) land classification and surface elevation datasets. The Cryosphere, 8(4): 1509-1518. https://doi.org/10.5194/tc-8-1509-2014

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

9 DOCUMENT INFORMATION

9.1 Publication Date

February 2017

9.2 Date Last Updated

September 2020