IceBridge-Related DMS-Derived L4 Sea Ice Surface Cover Classification Orthorectified Images, Version 1

USER GUIDE

How to Cite These Data

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

Polashenski, C., N. Wright, and S. McMichael. 2020. *IceBridge-Related DMS-Derived L4 Sea Ice Surface Cover Classification Orthorectified Images, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/1LI57H56EB7G. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/RDSISCO4

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1 DATA DESCRIPTION

This data set contains orthorectified sea ice surface classification images. A two-step approach was taken to create them. In the first, images from the *IceBridge DMS L0 Raw Imagery* data set were processed with the Open Source Sea-ice Processing Algorithm. Direct outputs from this first step are available in a separate data set (*IceBridge-Related DMS-Derived L4 Sea Ice Surface Cover Classification Images*). In the second step, the classified images were orthorectified using the digital elevation model from the *IceBridge DMS L3 Ames Stereo Pipeline Photogrammetric DEM* data set.

The imagery is classified into three main surface categories: snow and bare ice; melt ponds and submerged ice; and open water. The snow and ice category is further split into two subcategories based on melt state and/or ice thickness: snow and bright ice vs. dark and thin ice. Shadows are also detected and labeled in spring imagery. See Wright & Polashenski (2018) for a full description of surface categories.

1.1 Parameters

The parameter provided in this data set is sea ice surface classification with values ranging from 0 to 5, as summarized in Table 1 below:

Table 1. Sea Ice Surface Classes

Parameter value	Sea ice surface class
0	No data
1	Snow and bright ice
2	Dark and thin ice
3	Melt ponds and submerged ice
4	Open water
5	Ridge shadows

1.2 File Information

1.2.1 Format

Data files are provided in GeoTIFF (.tif) format; quality score files in CSV (.csv) format and metadata files in XML (.xml) format are also provided.

1.2.2 File Contents

Each processed image is stored in an 8-bit unsigned integer GeoTIFF file with pixel values from 0 to 5, representing the classification described in Table 1. A metadata CSV file is included for each processed IceBridge flight that contains, for each DMS frame, the total number of pixels in each sea ice surface category and the estimated quality of the source image. The same metadata CSV files are included in the *IceBridge-Related DMS-Derived L4 Sea Ice Surface Cover Classification Images* data set.

1.2.3 Naming Convention

Example file name:

RDSISCO4_2017_04_11_00008_classified_ortho.tif
GR_20100323_metadata.csv

The files are named according to the following convention, which is described in more detail in Table 2:

RDSISCO4_yyyy_mm_dd_NNNNN_classified_ortho.ext
LL_YYYYMMDD_metadata.csv

Table 2. File Naming Convention

Segment of file name	Description
`RDSISCO4`	Data set ID
`yyyy_mm_dd`	Year, month, and day of measurement for data files
`NNNNN`	Frame number from the digital mapping system (DMS) camera
`classified_ortho`	File content type: orthorectified, classified images
`LL`	Location: Greenland (GR)
`YYYYMMDD`	Year, month, and day of measurement for metadata files
`.ext`	File type: `.tif`: GeoTIFF data file `.csv`: CSV quality score file `.xml`: XML metadata file

1.3 Spatial Information

1.3.1 Coverage

This data set covers areas within the following geographical boundaries:

Southernmost latitude: 60° N

Northernmost latitude: 90° N

Westernmost longitude: 180° W

Easternmost longitude: 180° E

1.3.2 Resolution

The resolution of the imagery depends on the height of the aircraft above the ground, and thus varies from file to file. On average, the images have a resolution of 10 to 20 cm per pixel.

1.3.3 Geolocation

The following table provides information for geolocating this data set.

Table 3. Geolocation Details

Geographic coordinate system	WGS 84
Projected coordinate system	WGS 84 / NSIDC Sea Ice Polar Stereographic North
Central meridian	-45° E
Latitude of true origin	70° N
Scale factor at longitude of true origin	1
Datum	WGS 84
Ellipsoid/spheroid	WGS 84
Units	meters
False easting	0
False northing	0
EPSG code	3413
PROJ4 string	+proj=stere +lat_0=90 +lat_ts=70 +lon_0=-45 +k=1 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs
Reference	https://epsg.io/3413

1.4 Temporal Information

1.4.1 Coverage

23 March 2010 to 25 July 2017

1.4.2 Resolution

Varies

2 DATA ACQUISITION AND PROCESSING

2.1 Input Data

The following data sets were used as input data:

IceBridge DMS L0 Raw Imagery

IceBridge-Related DMS-Derived L4 Sea Ice Surface Cover Classification Images

IceBridge DMS L3 Ames Stereo Pipeline Photogrammetric DEM

2.2 Algorithm

The sea ice surface classification algorithm is described in detail in Wright & Polashenski (2018), and the code is available for download at https://github.com/wrightni/OSSP.

2.3 Processing Steps

2.3.1 Sea Ice Classification

The IceBridge DMS L0 raw imagery is first optimized with an automated linear histogram stretch and single-point white balance. These adjustments correct for poor surface illumination, often a result of high solar zenith angles or the aircraft flying under cloud cover. The high- and low-frequency image features (obtained via the Fourier transform) of optimized images are analyzed at this step to create the quality score following the approach in De & Masilamani (2013).

The image is then segmented into groups of similar pixels, called objects. Image segmentation is done as follows:

1. Natural boundaries between the sea ice surface types (e.g. the boundary between and ice floe and open ocean) are detected with a Canny edge detector applied to the green channel of the input JPG image.
2. The entire image is converted into a pixel intensity gradient image by applying a Scharr filter to the blue channel of the input JPG image.
3. A watershed segmentation method is used build complete objects based on the edge locations and intensity gradient. A marker is placed at all local maximum distances to the nearest detected edge. These markers indicate the origin of watershed regions. Each region then iteratively expands in all directions of increasing image gradient until

encountering a local maximum in the gradient image or encountering a separately growing region. This continues until every pixel in the source image belongs to a unique set.

With the proper parameter selection, each object should represent a single, still unknown, surface type. These objects are then categorized into the correct surface type using a random forest machine learning model. The training dataset used for machine learning was created by a group of experts in the sea ice field. The algorithm uses the training data to predict the category of unknown objects in the images. Final labeled images are created by replacing the values within each image object by the predicted surface label number.

Note: Data were processed with a universal training dataset that attempts to maximize performance on the widest range of input images. Lower-quality input imagery can often be successfully processed with a custom training dataset for specific areas of interest.

2.3.2 Orthorectification

The classified images were orthorectified using digital elevation models from the NASA Ames Stereo Pipeline, provided in the *IceBridge DMS L3 Ames Stereo Pipeline Photogrammetric DEM* data set.

2.4 Quality, Errors, and Limitations

In cases where the source optical imagery is of high quality, the average accuracy of this surface labeling scheme exceeds 96%. Specific details of the algorithm accuracy can be found in the related reference (Wright & Polashenski, 2018).

The primary source of error in this data set is cloud cover or haze obscuring the sea ice/ocean surface. The quality of the input imagery is reflected in the labeled image; opaque cloud and haze cover prevents surface classification while partial coverage or transparent mist will degrade labeled results. Transparent haze and mist cover will cause ocean areas to appear brighter than in reality and cause them to be categorized as ponds.

The quality score available in the metadata CSV attempts to alert users to low quality input imagery due to surface obstruction. A quality score of less than 0.025 should typically be discarded, and images with a quality less than 0.03 should be used with caution. This metric is a useful reference but does not flag 100% of poor-quality images. Users should inspect the raw imagery for possible surface obstructions.

Some flights do not have orthorectified files due to a lack of the necessary camera calibration data. The non-orthorectified images are available in *IceBridge-Related DMS-Derived L4 Sea Ice Surface Cover Classification Images*.

3 SOFTWARE AND TOOLS

Software that recognizes the GeoTIFF file format is recommended for these images, such as the GIS software QGIS or ArcGIS. See also the libGeoTIFF and GDAL websites for more information.

4 RELATED DATA SETS

IceBridge DMS L0 Raw Imagery

IceBridge-Related DMS-Derived L4 Sea Ice Surface Cover Classification Images

IceBridge DMS L3 Ames Stereo Pipeline Photogrammetric DEM

5 RELATED WEBSITES

Operation IceBridge web page at NSIDC

Operation IceBridge web page at NASA

6 CONTACTS

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7 REFERENCES

Wright, N. C., & Polashenski, C. M. (2018). Open-source algorithm for detecting sea ice surface features in high-resolution optical imagery. The Cryosphere, 12(4), 1307–1329. https://doi.org/10.5194/tc-12-1307-2018

De, K., & Masilamani, V. (2013). Image Sharpness Measure for Blurred Images in Frequency Domain. Procedia Engineering, 64, 149–158. https://doi.org/10.1016/j.proeng.2013.09.086

8 DOCUMENT INFORMATION

8.1 Publication Date

16 September 2019

8.2 Date Last Updated

17 February 2020