IceBridge WISE L2 Ice Thickness and Surface Elevation, 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, C. Larsen, Y. Gim, and D. Kirchner. 2013. *IceBridge WISE L2 Ice Thickness and Surface Elevation, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/0ZBRL3GY720R. [Date Accessed].

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

Rignot, E., J. Mouginot, C. Larsen, Y. Gim, and D. Kirchner. 2013. *Low-frequency Radar Sounding of Temperate Ice Masses in Southern Alaska*, Geophysical Research Letters. 40. 5399-5405. https://doi.org/10.1002/2013GL057452.

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/IRWIS2

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1 DETAILED DATA DESCRIPTION

1.1 Format

The WISE L2 files are in Comma-Separated Values (CSV) text files. The radar data are divided into segments for each day of operation. The segment ID is YYYYMMDD where YYYY is the four-digit year, MM is the two-digit month from 1 to 12, DD is the two-digit day of the month from 1 to 31.

1.2 File Naming Convention

Example file names:

IRWIS2_Data_20120316.csv
IRWIS2_Data_20120316.csv.xml

The CSV files are named according to the following convention and file name variables are described in Table 1.

IRWIS2_Data_YYYYMMDD.csv

Table 1. File Naming Convention

Variable	Description
`IRWIS2`	Data set ID
`Data`	Data file
`YYYY`	4-digit year
`MM`	2-digit month
`DD`	2-digit date
`.csv`	indicates comma separated value ASCII text file

1.3 Spatial Coverage

Spatial coverage for the IceBridge WISE campaign in Southeastern coastal Alaska.

Southernmost Latitude: 58.7° N
Northernmost Latitude: 61.7° N
Westernmost Longitude: 148.6° W
Easternmost Longitude: 137.1° W

1.3.1 Spatial Resolution

Spatial Resolution varies by surface characteristics and aircraft flown, as shown in Table 2.

Table 2. Spatial Resolution

Data	Resolution
Along-track	The final product has an along-track resolution of about 100 m and a sample spacing of about 25 m
Depth	17 m resolution and precision of about 35 m. Actual target location is ambiguous for a rough surface since the off-nadir returns in the antenna footprint can hide the nadir return.

1.3.2 Projection and Grid Description

These data are provided in WGS-84 geodetic coordinates and WGS-84 ellipsoid elevation reference.

1.4 Temporal Coverage

16 March 2012 to 25 March 2012

1.4.1 Temporal Resolution

Annual

1.5 Parameter or Variable

The WISE L2 Ice Thickness data set contains measurements for Elevation, Surface, Bottom and Thickness.

1.5.1 Parameter Description

The CSV ASCII text files contain fields as described in Table 3.

Table 3. MATLAB File Parameter Description

Parameter	Description	Units
LAT	Latitude	Degrees North
LON	Longitude	Degrees East
TIME	UTC	Seconds of day

Parameter	Description	Units
THICK	Ice Thickness: Bottom minus Surface. Constant dielectric of 3.15 (no firn) is assumed for converting propagation delay into range. -9999 indicates no thickness available.	Meters
ELEVATION	Elevation referenced to WGS-84 Ellipsoid.	Meters
FRAME	Fixed length field. YYYY = year, MM = month, DD = day, HH = hour, MIN = minute, SS = second.	NA
SURFACE	Surface height referenced to WGS-84 Ellipsoid provided by an external dataset (see Dem_select below).	Meters
BOTTOM	Ice Bottom Elevation referenced to WGS-84 Ellipsoid. Constant dielectric of 3.15 (no firn) is assumed for converting propagation delay into range. -9999 indicates no thickness available.	Meters
QUALITY	1: High confidence pick 2: Medium confidence pick 3: Low confidence pick	NA
DATE	Day, Month, Year: DDMMYY	NA
DEM_SELECT	0: NASA IceBridge's University of Alaska, Fairbanks (UAF) LiDAR Scanner 1: National Elevation Model or Muskett et al. 2009*	

Note (*): Where surface elevation is not recorded by the LiDAR (Dem_select=1), we employ a Digital Elevation Model (DEM) from the Shuttle Radar Mapping Mission and from Intermap Technologies, Inc. (ITI), both acquired in the year 2000 (Muskett et al., 2009), or the USGS National Elevation Model which we adjust vertically at both ends of the missing surface segments and linearly interpolate in between to best fit the UAF laser elevation data of March 2012 and account for ice elevation change between 2000 and 2012. This data filling occurs over less than 30 percent of the flight tracks (Muskett et al., 2009).

1.5.2 Sample Data Record

The image below shows a selection of records from the IRMCR2_Data_20120320.csv data file. The fields in each record correspond to the parameters described in Table 3.

```
LAT,LON,TIME,THICK,ELEVATION,FRAME,SURFACE,BOTTOM,QUALITY,DATE,DEM_SELECT
61.383907,-148.063690,69611.0000,-9999.00,2587.7520,20120320T194055,1641.26,11640.26,0,200312,0
61.383881,-148.063217,69611.4453,-9999.00,2587.4773,20120320T194055,1642.00,11641.00,0,200312,0
61.383854,-148.062759,69611.8984,-9999.00,2587.2029,20120320T194055,1642.76,11641.76,0,200312,0
61.383827,-148.062302,69612.3516,-9999.00,2586.9282,20120320T194055,1643.52,11642.52,0,200312,0
61.383801,-148.061844,69612.7969,-9999.00,2586.6533,20120320T194055,1644.26,11643.26,0,200312,0
61.383774,-148.061371,69613.2500,-9999.00,2586.4604,20120320T194055,1645.02,11644.02,0,200312,0
61.383743,-148.060898,69613.7031,-9999.00,2586.3198,20120320T194055,1645.78,11644.78,0,200312,0
61.383713,-148.060440,69614.1562,-9999.00,2586.1245,20120320T194055,1646.53,11645.53,0,200312,0
61.383682,-148.059982,69614.6094,-9999.00,2585.8530,20120320T194055,1647.29,11646.29,0,200312,0
```

2 SOFTWARE AND TOOLS

CSV files may be opened by any text viewing program.

3 DATA ACQUISITION AND PROCESSING

3.1 Theory of Measurements

Ice thickness is typically determined using data collected from waveforms with different pulse durations. Generally, all receive channels are used to produce the best result. The two reflections that are of most interest are the ice surface and ice bottom. The difference in the propagation time between the ice surface and ice bottom reflections is then converted into ice thickness using an estimated ice index of refraction of ice (square root of 3.15). The media is assumed to be uniform, that is, no firn correction is applied.

Data collection modes used for typical operation are described in Section 3.2 Data Acquisition Methods.

3.2 Data Acquisition Methods

The radar is operated at a center frequency of 2.5 MHz, a 2 MHz bandwidth, with a sampling frequency of 20 MHz on 16 bits with a 50 μs data window, and a pulse repetition frequency of 1 kHz. The default operating power is 800 W peak power. In March 2012, WISE operated at 400 m above the surface on a DHC-3 Otter from Ultima Thule Lodge. For georeference of the data, a conventional GPS receiver is operated at 20 Hz along with the radar, with a precision of 10 m (Rignot et al., 2013)

3.3 Derivation Techniques and Algorithms

3.3.1 Processing Steps

1. The first stage of data processing is an incoherent averaging of radar echoes in the azimuth direction, followed by a range migration using an Omega-K algorithm.
2. The resulting echo diagrams are semi-automatically digitized to record the position of the ice surface and of the glacier bed.
3. The digitized bed is checked at crossing points with other tracks or other datasets for consistency to limit the possibility of false detection, for instance due to off-nadir radar reflections.

3.3.2 Error Sources

The primary error sources for ice penetrating radar data are system electronic noise, multiple reflectors also known as multiples, and off-nadir reflections. Each of these error sources can create spurious reflections in the trace data leading to false echo layers in profile data. Multiple reflectors arise when the radar energy reflects off two surfaces more than once (or resonates) in the vertical dimension, and then returns to the receive antenna. Reflections occur in situations when two or more large reflectors are present with large electromagnetic constitutive property changes, such as the ice surface (air/ground), the bottom of the ice, and the aircraft body which is also a strong reflector. The radar receiver only records time since the radar pulse was emitted, so variation in the constant dielectric used to convert time into ice thickness may lead to errors of few percent (dielectric constant is assumed to be 3.15).

3.4 Sensor or Instrument Description

As described on the WISE Radar page, the Warm Ice Sounding Explorer (WISE) operates over a 1 to 5 MHz frequency range for airborne sounding of ice sheets and ice caps. The radar bandwidth is 2 MHz.

4 REFERENCES AND RELATED PUBLICATIONS

Muskett, R. R., C. S. Lingle, J. M. Sauber, A. S. Post, W. V. Tangborn, B. T. Rabus, and K. A. Echelmeyer. 2009. Airborne and Spaceborne DEM and Laser Altimetry-derived Surface elevation and Volume Changes of the Bering Glacier System, Alaska, USA, and Yukon, Canada, 1972â€“2006, *Journal of Glaciology*, 55(190):316–326.

Rignot, E., J. Mouginot, C. F. Larsen, Y. Gim, and D. Kirchner. 2013. Low-frequency Radar Sounding of Temperate Ice Masses in Southern Alaska, *Geophysical Research Letters*, 40, doi:10.1002/2013GL057452.

4.1 Related Data Collections

IceBridge UAF Lidar Scanner L1B Geolocated Surface Elevation Triplets

4.2 Related Websites

Warm Ice Sounder Explorer (WISE), Rignot Research Group, Department of Earth System Science, University of California Irvine

5 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Publication Date

25 November 2013

6.2 Date Last Updated

30 October 2020