IceBridge UAF Lidar Scanner L1B Geolocated Surface Elevation Triplets, Version 1

USER GUIDE

How to Cite These Data

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

Larsen, C. 2010, updated 2020. *IceBridge UAF Lidar Scanner L1B Geolocated Surface Elevation Triplets, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/AATE4JJ91EHC. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/ILAKS1B

National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

1.1 Format

The UAF Lidar Scanner Level-1B Geolocated Surface Elevation Triplets data files are in LAS 1.2 sequential binary format. The LAS file format is a public file format for the interchange of 3-dimensional point cloud data between data users (ASPRS Standards Committee LASer (LAS) File Format Exchange Activities). Each data file is paired with an associated XML file, which contains additional metadata.

1.2 File Naming Convention

Files are named according to the following convention and as described in Table 1.

Example file names:

```
ILAKS1B_2013_239_Malaspina.las
ILAKS1B_2013_239_Malaspina.las.xml
```

File naming convention:

```
ILAKS1B_YYYY_NNN.AAAA.xxx
```

Table 1. File Naming Convention

Variable	Description
ILAKS1B	Data set ID
YYYY	Four-digit year of data collection
NNN	Three-digit day in acquisition year
AAAA	Glacier name (optional; only applies to Alaska campaigns)
.xxx	Indicates file type. For example: LAS 1.2 file (.las) or XML metadata file (.las.xml)

1.3 Spatial Coverage

Spatial coverage for the IceBridge UAF Lidar Scanner Level-1B Geolocated Surface Elevation Triplets campaigns:

Alaska:

Southernmost Latitude: 55° N

Northernmost Latitude: 72° N

Westernmost Longitude: 156° W

Easternmost Longitude: 130° W

Antarctica:

Southernmost Latitude: 90° S

Northernmost Latitude: 53° S

Westernmost Longitude: 180° W

Easternmost Longitude: 180° E

1.3.1 Spatial Resolution

The footprint on the ground of the laser shot points is on the order of 20 cm in diameter. Average spacing along path and perpendicular to the flight path is roughly 1 m by 1 m, subject to Height Above Ground (HAG) flown and attitude of the aircraft. Preferred HAG is 500 to 600 m. Optimal conditions result in a swath of 500 to 600 m width with a 1 m by 1 m density.

1.3.2 Projection and Grid Description

The data are provided with Universal Transverse Mercator (UTM) eastings and northings. Geoid values are not included.

1.4 Temporal Coverage

19 August 2009 to 05 June 2020

1.4.1 Temporal Resolution

IceBridge campaigns are conducted on an annually repeating basis. Alaska campaigns are conducted during May, June, July, August, and September, and Antarctic campaigns are conducted during October and November.

1.5 Parameter or Variable

This data set contains elevation measurements with UTM easting and northing.

1.5.1 Parameter Description

Parameters contained in the data files are described in Table 2. Column numbers 1 to 3 represent columns left-to-right in the data. Columns are not numbered in the data files.

Table 2. Parameter Description and Units

Column	Description	Units
1	UTM Easting	Meters
2	UTM Northing	Meters
3	Elevation (Height Above Ellipsoid (HAE))	Meters

2 SOFTWARE AND TOOLS

LAS files can be opened using tools available from the ASPRS Lidar Data Translation Toolset website. See also the LAStools web page for various tools for converting, filtering, viewing, processing, and compressing LAS format lidar data.

3 DATA ACQUISITION AND PROCESSING

The UAF altimetry data are comprised of a series of point measurements on the surface of glaciers recorded from an aircraft. Each point is derived from a pulsed laser range measurement combined with aircraft Global Positioning System Inertial Measurement Unit (GPS/IMU) positioning and orientation measurements. The footprint on the ground of the laser shot points is on the order of 20 cm in diameter. Coordinates and elevation for each point are referenced in the International Terrestrial Reference Frame (ITRF00) and are accurate to within +/- 30 cm. Longitude/latitude values are derived by projecting the ITRF coordinates into WGS 84. Easting and northing values are in UTM zones 6, 7, and 8. All vertical data are in HAE.

3.1 Data Acquisition Methods

The GPS records the position of the aircraft every second as it flies over a glacier. The laser continually measures the distance between the aircraft and the glacier surface, and the gyroscope measures the direction the laser is pointing.

The Riegl scanner has a 60-degree beam sweep, range up to 650 m, and measures 20,000 data points per second. The IMU measures the aircraft attitude (pitch, roll, yaw, and rates about those axes) and several other measurements, all at 100 times per second. The Trimble GPS records raw, dual frequency data which is post-processed after the survey against similar data recorded at a fixed GPS base station to provide precise positioning of the aircraft. At typical aircraft speeds and

heights data are collected on a roughly 1 m by 1 m grid along a 500-meter-wide swath (UAF Glacier Lidar System web page).

3.2 Derivation Techniques and Algorithms

3.2.1 Processing Steps

The following processing steps are performed by the data provider.

1. All GPS processing of the aircraft position uses L1 frequency 1575.42 MHz and L2 frequency 1227.6 MHz data recorded at 5 Hz, processed with the TRACK GPS differential phase kinematic positioning program, a module of the GAMIT/GLOBK software programs from the Department of Earth Atmospheric and Planetary Sciences, MIT. For further information on TRACK, see http://geoweb.mit.edu/~tah/track_example.
2. GPS base station coordinates are found using Online Positioning User Service (OPUS). For further information on OPUS, see http://www.ngs.noaa.gov/OPUS/. The kinematic processing and the laser shot point coordinates are referenced to these base station coordinates.

3.2.2 Version History

On 21 September 2012, the 2009 and 2010 data were replaced with Version 1.1 reprocessed data. The reprocessing involved:

1. Identifying and correcting infrequent timing shifts wherein the laser scanner data and IMU/GPS data were misaligned by 1 or 2 integer seconds. This only concerned a small handful of files, but the effect can introduce errors on the order of 10's to 100's of meters in horizontal and vertical coordinates of the point cloud data.
2. Applying corrected boresight angles, that is, the small angular offsets between the IMU/GPS reference frame and the laser vector. These corrections were applied to all data. The previous, incorrect boresight angles introduced errors on the order of meters to 10's of meters in the horizontal and vertical coordinates of the point cloud data.
3. Cleaning of spurious data points that did not represent real targets or surfaces. These appear in the previous versions of these data as random, individual points far away from the surfaces being imaged.

3.3 Sensor or Instrument Description

The UAF lidar scanner is a laser altimetry system used for measuring surface elevation changes of glaciers throughout Alaska and western Canada. The altimetry system consists of a highly accurate GPS receiver, a laser, and a gyroscope.

The main components of the UAF lidar scanner are a Riegl LMS-Q240i scanning laser altimeter, an Oxford Technical Solutions Inertial+2 inertial measurement unit, a Trimble R7 geodetic GPS receiver, and a small form factor PC for data logging.

4 REFERENCES AND RELATED PUBLICATIONS

Kwok, R., G. F. Cunningham, S. S. Manizade, and W. B. Krabill. 2012. Arctic sea ice freeboard from IceBridge acquisitions in 2009: Estimates and comparisons with ICESat. *Journal of Geophysical Research* 117: C02018. doi:10.1029/2011JC007654.

4.1 Related Data Collections

- IceBridge UAF Lidar Profiler L1B Geolocated Surface Elevation Triplets
- IceBridge UAF GPS/IMU L1B Corrected Position and Attitude Data

4.2 Related Websites

- GAMIT-GLOBK, MIT Department of Earth Atmospheric and Planetary Sciences
- IceBridge data website at NSIDC
- IceBridge website at NASA
- ICESat/GLAS website at NASA Wallops Flight Facility
- ICESat/GLAS website at NSIDC
- NOAA OPUS: Online Positioning User Service
- Airborne LiDAR at UAF-GI

5 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Publication Date

14 February 2017

6.2 Date Last Updated

15 December 2020