IceBridge LVIS L2 Geolocated Surface Elevation Product, Version 1

USER GUIDE

How to Cite These Data

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

Blair, J. B. and M. Hofton. 2010, updated 2018. *IceBridge LVIS L2 Geolocated Surface Elevation Product, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/OIKFGJNBM6OO [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/ILVIS2

National Snow and Ice Data Center

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1 DATA DESCRIPTION

Note: If you downloaded the 2010 Greenland data before 13 April 2012, please download the new Version 1.1 2010 Greenland data files at your convenience. All of the 2010 Greenland data for this data set were replaced on 13 April 2012. Some incorrect values occurred in the previous version of these files and were corrected for the Version 1.1 data.

In 2014, only the ARISE Alaska campaign was flown (no Greenland or Antarctica campaigns). These data from 2 September 2014 to 2 October 2014 are stored in the folders `/2014.09.02/` through `/2014.10.02/.`

1.1 File Information

1.1.1 Format

The data files are in ASCII text format. Each data file is paired with an associated XML file, which contains additional metadata.

1.1.2 Naming Convention

The data files are named according to the following convention and as described in Table 1:

`ILVIS2_LOYYYY_MMDD_RYYMM_nnnnnn.xxx`

Example file names:

`ILVIS2_GL2013_1114_R1406_043900.TXT`
`ILVIS2_GL2013_1114_R1406_043900.TXT.xml`

Table 1. File Naming Convention

Variable	Description
`ILVIS2`	Short name for IceBridge LVIS L2 Geolocated Surface Elevation Product
`LOYYYY`	Campaign identifier. LO = location, where GL = Greenland and AQ = Antarctica*. YYYY= four-digit year of campaign
`MMDD`	Two-digit month, two-digit day of campaign
`RYYMM`	Date (YY year / MM month) of data release
`nnnnnn`	Number of seconds since UTC midnight of the day on which the data collection started
`.xxx`	Indicates file type: ASCII data file (.TXT) XML metadata file (.TXT.xml)

*The 2014 ARISE Alaska campaign file names contain the same campaign identifier as the Greenland file names (GL).

1.2 File Size

The total data file volume is approximately 130 GB.

1.3 Spatial Information

1.3.1 Coverage

Spatial coverage for this data set includes the Arctic, Greenland, Alaska, Antarctica, and surrounding ocean areas. In effect, this represents the coverage noted below.

Arctic / Greenland:
Southernmost Latitude: 60° N
Northernmost Latitude: 90° N
Westernmost Longitude: 180° W
Easternmost Longitude: 180° E

Antarctic:
Southernmost Latitude: 90° S
Northernmost Latitude: 53° S
Westernmost Longitude: 180° W
Easternmost Longitude: 180° E

Alaska:
Southernmost Latitude: 72° N
Northernmost Latitude: 75° N
Westernmost Longitude: 160° W
Easternmost Longitude: 140° W

1.3.2 Spatial Resolution

Spatial resolution is nominally 20 m but varies with aircraft altitude. Laser spot size is a function of beam divergence and altitude. Nominal spot spacing is a function of scan rate and pulse repetition rate.

1.3.3 Projection and Grid Description

International Terrestrial Reference Frame (ITRF 2000), WGS-84 Ellipsoid.

1.4 Temporal Coverage

14 April 2009 to 31 October 2015

1.4.1 Temporal Resolution

IceBridge campaigns are conducted on an annually repeating basis. Arctic, Greenland, and Alaska campaigns are typically conducted in March, April, and May; Antarctic campaigns are typically conducted in October and November.

1.5 Parameter or Variable

This data set includes mean elevation and other height measurements.

1.5.1 Parameter Description

The ASCII text files contain the fields described in Table 2.

Table 2. ASCII Text File Parameter Description

Parameter	Description	Units
LVIS_LFID	LVIS file identification, including date and time of collection and file number. Values three through seven in the first field represent the Modified Julian Date of the data collection.	n/a
SHOTNUMBER	Laser shot assigned during collection	n/a
TIME	UTC decimal seconds of the day	Seconds
LONGITUDE_CENTROID	Centroid longitude of the corresponding LVIS Level-1B waveform	Degrees east
LATITUDE_CENTROID	Centroid latitude of the corresponding LVIS Level-1B waveform	Degrees north
ELEVATION_CENTROID	Centroid elevation of the corresponding LVIS Level-1B waveform	Meters
LONGITUDE_LOW	Longitude of the center of the lowest mode in the waveform	Degrees east
LATITUDE_LOW	Latitude of the center of the lowest mode in the waveform	Degrees north
ELEVATION_LOW	Elevation of the center of the lowest mode in the waveform	Meters
LONGITUDE_HIGH	Longitude of the center of the highest mode in the waveform	Degrees east

Parameter	Description	Units
LATITUDE_HIGH	Latitude of the center of the highest mode in the waveform	Degrees north
ELEVATION_HIGH	Elevation of the center of the highest mode in the waveform	Meters

1.5.2 Sample Data Records

Figure 1 shows the first five records from the ASCII data file ILVIS2_GL2013_1105_R1406_044313.TXT. The twelve columns in each record correspond to the parameters described in Table 2.

```
# LVIS_LFID SHOTNUMBER TIME LONGITUDE_CENTROID LATITUDE_CENTROID
ELEVATION_CENTROID LONGITUDE_LOW LATITUDE_LOW ELEVATION_LOW
LONGITUDE_HIGH LATITUDE_HIGH ELEVATION_HIGH

1656601002   236872  44313.67642  291.707127  77.000005   1076.717
291.707127  77.000005   1077.057 291.707127  77.000005   1077.057

1656601002   236973  44313.77742  291.707758  77.000024   1077.029
291.707758  77.000024   1077.379 291.707758  77.000024   1077.379

1656601002   236974  44313.77842  291.707526  77.000051   1076.811
291.707527  77.000050   1077.100 291.707527  77.000050   1077.100

1656601002   236975  44313.77942  291.707295  77.000077   1076.715
291.707295  77.000076   1077.004 291.707295  77.000076   1077.004

1656601002   236992  44313.79642  291.707387  77.000122   1076.629
291.707387  77.000121   1076.952 291.707387  77.000121   1076.952
```

Figure 1. Snapshot of the first five records from file ILVIS2_GL2013_1105_R1406_044313.TXT. The column headings and values are wrapped to fit into the figure.

2 DATA ACQUISITION AND PROCESSING

2.1 Acquisition

A laser altimeter is an instrument that measures the range from the instrument to a target object or surface. The device sends a laser beam toward the target, and measures the time it takes for the signal to reflect back from the surface. Knowing the precise round-trip time for the signal to return yields the range to the target.

Figure 2 shows two examples of return energy waveforms. A simple waveform occurs where the ice surface is relatively smooth within the footprint of the laser pulse (approximately 20 m in

diameter). The mean noise level provides the threshold relative to which the centroid and all modes are computed. A complex waveform might be returned from a rougher ice surface and could contain more than one mode, originating from different reflecting surfaces within the laser footprint, such as crevasse sides and bottom, open water, large snowdrifts, and other steep or multiple slopes. A complex waveform would be more typically returned from multilevel vegetation land cover such as a forest.

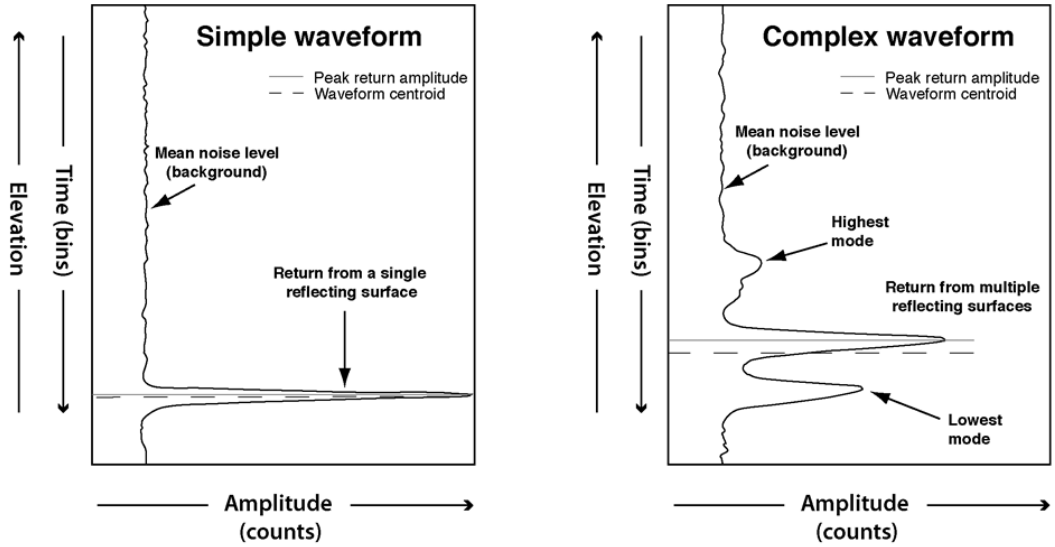

Figure 2 . Sample Level-1B product waveforms from which the Level-2 products are derived.

2.2 Processing

LVIS employs a signal digitizer, disciplined with a very precise oscillator, to measure both the transmitted and reflected laser pulse energies versus time. These digitized and captured photon histories are known as waveforms. For the outgoing pulse, it represents the profile of the individual laser shot, and for the return pulse it records the interaction of that transmitted pulse with the target surface.

Processing of these waveforms yields many products; however, the primary products are the range from the instrument to the Earth's surface and the distribution of reflecting surfaces within the laser footprint area. For vegetated terrain, these surfaces include tree canopies, branches, other forms of vegetation, and open ground. For cryospheric data, these surfaces are snow, ice, crevasses, snowdrifts, and sea ice, possibly interspersed with open ocean, exposed rock, and water.

LVIS uses a waveform-based measurement technique to collect data instead of just timing detected returns of the laser pulse. The return signal is sampled rapidly, and stored completely for each laser shot. Retaining all waveform information allows post-processing of the data to extract

many different products. With the entire vertical extent of surface features recorded, metrics can be extracted about the sampled area. An advantage of saving all of the waveform data is that new techniques can be applied to these data long after collection to extract even more information. For more information, see the NASA LVIS website.

2.3 Derivation Techniques and Algorithms

2.3.1 Processing Steps

This data set is derived from the LVIS Level-1B Geolocated Return Laser Waveform product. The following processing steps are performed by the data provider to produce the Level-2 data in ASCII text format.

1. Proceeding from the Level-1B waveform, a background or threshold return energy level is first determined. This threshold forms the datum to which the subsequent measurements are referenced.

2. The centroid of the waveform above the threshold is computed. The centroid represents the mean location and mean elevation of all reflecting surfaces within the laser footprint.

3. All modes in the waveform are identified, followed by selection of the highest and lowest modes for output. These correspond to the mean elevation of the highest and lowest reflecting surfaces, respectively, within the laser footprint.

2.4 Instrumentation

2.4.1 Description

LVIS is an airborne lidar scanning laser altimeter used by NASA to collect surface topography and vegetation coverage data. LVIS uses a signal digitizer with oscillator to measure transmitted and reflected laser pulse energies versus time and capture photon histories as waveforms. The laser beam and telescope field of view scan a raster pattern along the surface perpendicular to the aircraft heading as the aircraft travels over a target area. LVIS has a scan angle of approximately 12°, and can cover 2 km swaths from an altitude of 10 km. A typical collection size is 10 m to 25 m spots. In addition to waveform data, GPS satellite data are recorded at ground tie locations and on the airborne platform to precisely reference the aircraft position. An IMU is attached directly to the LVIS instrument and provides information required for coordinate determination.

3 SOFTWARE AND TOOLS

The data files can be opened by any software that reads ASCII text files.

Also available: read_ilvis2.pro, an IDL program that reads the LVIS Level-2 data into an IDL structure.

4 RELATED DATA SETS

- Antarctic 5-km Digital Elevation Model from ERS-1 Altimetry
- GLAS/ICESat 500 m Laser Altimetry Digital Elevation Model of Antarctica
- GLAS/ICESat L1B Global Elevation Data
- IceBridge ATM L1B Qfit Elevation and Return Strength
- IceBridge LVIS L2 Geolocated Surface Elevation Product
- IceBridge ATM L1B Qfit Elevation and Return Strength
- Pre-IceBridge ATM L2 Icessn Elevation, Slope, and Roughness

5 RELATED WEBSITES

- LVIS webpage at NASA Goddard Space Flight Center
- IceBridge at NSIDC
- IceBridge at NASA
- ICESat/GLAS at NSIDC

6 CONTACTS AND ACKNOWLEDGMENTS

Bryan Blair
Laser Remote Sensing Laboratory, Code 694
NASA Goddard Space Flight Center
Greenbelt, MD 20771

Michelle Hofton
Department of Geography
2181 LeFrak Hall
University of Maryland
College Park, MD 20742

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7 REFERENCES

Blair, J. B., D. L. Rabine, and M. A. Hofton. 1999. The Laser Vegetation Imaging Sensor: a medium-altitude, digitisation-only, airborne laser altimeter for mapping vegetation and topography. ISPRS Journal of Photogrammetry and Remote Sensing, 54(2–3): 115–122. https://doi.org/10.1016/S0924-2716(99)00002-7

Hofton, M. A., J. B. Blair, S. B. Luthcke, and D. L. Rabine. 2008. Assessing the performance of 20–25 m footprint waveform lidar data collected in ICESat data corridors in Greenland. Geophysical Research Letters, 35(24): L24501. https://doi.org/10.1029/2008GL035774.

8 DOCUMENT INFORMATION

8.1 Publication Date

July 2012

8.2 Date Last Updated

June 2023