IceBridge LVIS L0 Raw Ranges, Version 1

USER GUIDE

How to Cite These Data

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

Hofton, M. and J. B. Blair. 2011, updated 2018. *IceBridge LVIS L0 Raw Ranges, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/E6JPQ3QNW77R. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/ILVIS0

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 File Information

1.1.1 Format

Files in the LVIS Level-0 data set include binary laser altimeter, Inertial Measurement Unit and Global Positioning System data, binary JPEG images, and ASCII text files. All contain raw, unprocessed data.

1.1.2 File and Directory Structure

The data set includes several file types:

- LVIS laser altimeter data (rtlvis) as binary or ascii text files
- Inertial Measurement Unit data (applanix or gyro) as binary or ASCII text files
- high resolution camera (camera) JPEG files
- Global Positioning System data (gps) as binary or ascii text files
- aircraft position, attitude, and motion data (planedata) ascii text files

Some data files correspond to separate individual instruments. Examples are:

- camera1 and camera2
- atm_applanix and lvis_applanix
- applanix 510 and applanix 610
- applanix LVIS and applanix AMES
- gps base, and gps remote, and gps plane

1.2 Volume

The data volume for the full data set is approximately 29 TB.

1.3 Spatial Coverage

Spatial coverage 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

Antarctica:

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

1.3.1 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.

1.3.2 Projection and Grid Description

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

1.4 Temporal Coverage

14 April 2009 to 20 September 2017

1.4.1 Temporal Resolution

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

1.5 Parameter or Variable

The primary data parameter in this data set is the raw laser altimeter measurement from the LVIS instrument. Additional supporting parameters include raw GPS and aircraft position, attitude, and motion readings. These files, provided for archival purposes, contain the raw data processed by the LVIS instrument team using proprietary software to create the following data sets: IceBridge LVIS

Level-1B Geolocated Return Energy Waveforms and IceBridge LVIS Level-2 Geolocated Surface Elevation Product.

2 DATA ACQUISITION AND PROCESSING

As described on the NASA LVIS website, 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 reflection to return yields the range to the target.

Figure 1 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). Mean noise level, provided with the Level-1B data product, provides the threshold relative to which the centroid and all modes are later computed for the Level-2 data product. 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 landcover such as a forest.

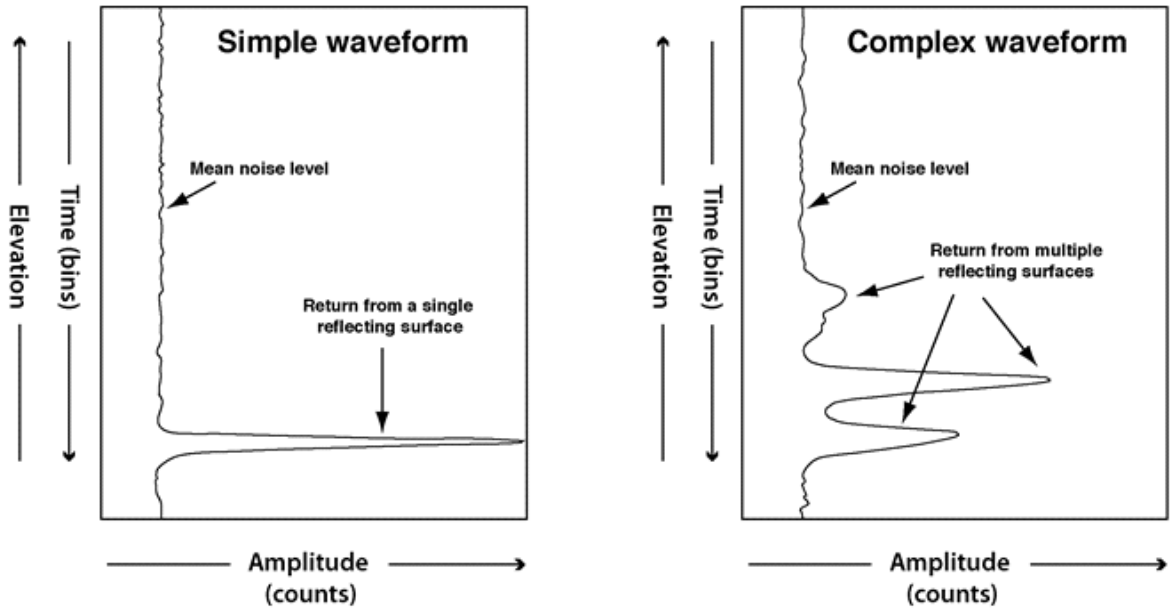

Figure 1. Sample Level-1B Product Waveforms Illustrating Some Possible Distributions of Reflected Light

2.1.1 Data Acquisition Methods

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, but the primary product is range from the instrument to the Earth's surface and the distribution of reflecting surfaces within the area of the laser footprint. For vegetated terrain these surfaces are 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. See the NASA LVIS website.

2.2 Derivation Techniques and Algorithms

The LVIS Level-0 data are raw unprocessed data. No derivation techniques, algorithms, or processing steps are used.

3 SOFTWARE AND TOOLS

As described on the NASA LVIS website, the Land, Vegetation, and Ice Sensor is an airborne lidar scanning laser altimeter used by NASA for collecting surface topography and vegetation coverage data. LVIS uses a signal digitizer with oscillator to measure transmitted and reflected laser pulse energies versus time capturing photon histories as waveforms. The laser beam and telescope field of view scan a raster pattern along the surface perpendicular to 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. Typical collection size is 10 m to 25 m spots. In addition to waveform data, GPS satellite data is recorded at ground tie locations and on the airborne platform to precisely reference aircraft position. An IMU is attached directly to the LVIS instrument and provides information required for coordinate determination.

4 RELATED DATA SETS

- IceBridge LVIS L1B Geolocated Return Energy Waveforms
- IceBridge LVIS L2 Geolocated Surface Elevation Product

5 RELATED WEBSITES

- LVIS website at NASA Goddard Space Flight Center
- IceBridge data website at NSIDC
- IceBridge website at NASA
- ICESat/GLAS website at NASA Wallops Flight Facility
- ICESat/GLAS website at NSIDC

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6.1 Acknowledgments:

This work was supported by NASA Grant Number NNX11AH69G, LVIS: A Topographic Mapping Capability for IceBridge.

7 REFERENCES

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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: L24501, doi:10.1029/2008GL035774.

8 DOCUMENT INFORMATION

8.1 Publication Date

October 2012

8.2 Date Last Updated

December 2018