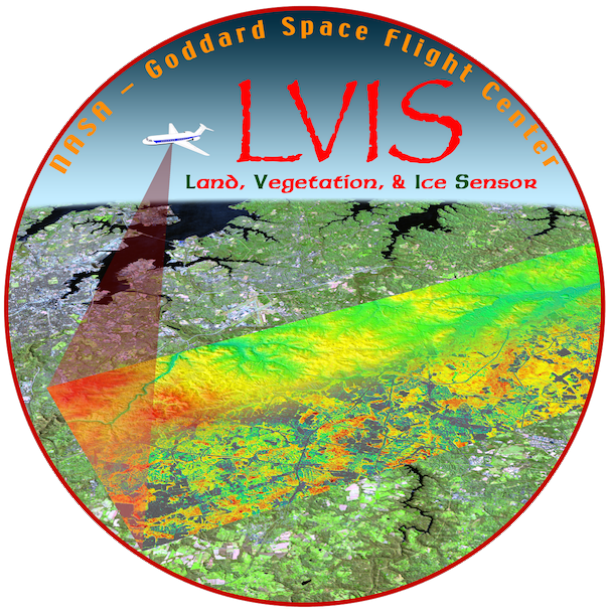
NASA's Land, Vegetation, and Ice Sensor (LVIS) Facility

Technical Reference Document



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Document History

Revision	Publication Date	Description
1.0	2023-03-14	Baseline Document
1.1	2023-07-25	Geographical extents corrected
1.2	2023-10-03	Added Gabon 2023 Classic and Camera data
1.3	2024-05-23	Added BioSCape 2023 Corrected release file numbers for ABoVE 2019
1.3.1	2024-07-23	Added file numbers for BioSCape 2023 imagery Corrected release file numbers for GL2022_04
1.4	2024-07-25	Added Lake Ice 2024
1.4.1	2024-11-18	Added file numbers for Lake Ice 2024 Canon images
1.5	2025-03-11	Added SARP 2024 Added ARCSIX 2024 imagery
1.5.1	2025-03-25	Added ARCSIX 2024 Level 1B and Level 2 files
1.5.2	2025-07-24	Updated the Classic Gabon 2023 release to R2507
1.6	2025-11-14	Added Costa Rica and Panama 1998, US 1999, and Arkansas 2006. Added links to older LVIS releases.

Table of Contents

1. Introduction

NASA's LVIS Facility is an imaging lidar and camera sensor suite for precise and accurate large-area surface mapping and characterization. The Facility uses airborne lidar scanning laser altimeters to collect elevation and 3D surface structure information over land, ocean, and ice surfaces, along with downward-looking, high-resolution camera imagery. The LVIS instruments differ in laser footprint size and spacing on the ground but generate near-identical data products. Two LVIS instruments may be co-mounted on the same platform and operated during flights, with data products referred to as LVISC (from the LVIS-Classic instrument) and LVISF (from the LVIS-Facility instrument).

2. Campaign Overviews

2.1. United States 2018-2019

Engineering Check Flights were flown in over sites in Maryland, Virginia, and North Carolina on 7 November 2018 and 31 January 2019 out of NASA's Langley Research Center in Hampton, VA.

Sample file names:

- LVISF1B_US2018_1107_R2011_067463.h5
- LVISF2_US2019_0131_R2011_067202.TXT
- OLVIS1A_CAM1_US2019_0131_R2011_069041.JPG

2.2. GEDI 2019

In May-June 2019, the NASA LVIS Facility was deployed to sites in the southeastern United States as well as Central America as part of an airborne campaign to provide calibration and validation of the Global Ecosystem Dynamics Investigation (GEDI) payload on the International Space Station. Flights were based out of Ellington Field in Houston, TX.

Sample file names:

- LVISC1B_GEDI2019_0521_R2002_075050.h5
- LVISC2_GEDI2019_0523_R2002_069080.TXT
- LVISF1B_GEDI2019_0524_R2003_066446.h5
- LVISF2_GEDI2019_0529_R2003_080145.TXT
- OLVIS1A_CAM1_GEDI2019_0529_R2005_080517.JPG
- OLVIS1A_CAM2_GEDI2019_0604_R2005_072244.JPG

2.3. ABoVE 2019

In July-August 2019, the NASA LVIS Facility was deployed to sites in northern Canada and Alaska as part of NASA's Arctic-Boreal Vulnerability Experiment (ABoVE) 2019 airborne campaign. Flights were based out of multiple airports in Canada and Alaska.

Sample file names:

- LVISC1B_ABoVE2019_0713_R2002_058325.h5
- LVISC2_ABoVE2019_0715_R2002_073955.TXT
- LVISF1B_ABoVE2019_0718_R2003_070393.h5
- LVISF2_ABoVE2019_0725_R2003_079186.TXT
- OLVIS1A_CAM1_ABoVE2019_0729_R2005_062415.JPG
- OLVIS1A_CAM2_ABoVE2019_0801_R2005_090836.JPG

2.4. GEDI 2021

In July-August 2021, NASA's LVIS Facility flew over the eastern US and French Guiana collecting calibration and validation data for NASA's GEDI. Two LVIS lidars and two camera sensors were operated on the NASA G-V aircraft. Flights were based out of Baltimore, MD and San Juan, PR. Science targets in the US and French Guiana included sections of GEDI reference ground tracks, existing ground-based data collections, and previous LVIS data collection sites.

Sample file names:

- LVISC1B_GEDI2021_0720_R2112_051758.h5
- LVISC2_GEDI2021_0723_R2112_049947.TXT
- LVISF1B_GEDI2021_0727_R2203_065245.h5
- LVISF2_GEDI2021_0729_R2203_070230.TXT
- OLVIS1A_CAM1_GEDI2021_0731_R2111_042191.JPG
- OLVIS1A_CAM2_GEDI2021_0805_R2111_067580.JPG

2.5. Greenland Spring 2022

In April 2022, NASA's LVIS Facility was used to collect data over sections of the Greenland Ice Sheet and surrounding sea ice, supporting University of Kansas/CReSIS radar flights or future sensor design studies. The LVIS-F lidar sensor was used to collect surface elevation and structure information at low (500 m AGL) or medium (7,000 m) flight altitudes in the NASA P3B, operating with 2 LVIS camera sensors and the KU/CReSIS radar sensor. Because of the different flight altitudes, collection parameters of the LVIS lidar and cameras varied (see mission information tables below for further details).

Table 1. LVISF Product Release History

Release	Date	Products	Description
R2210	October 2022	LVISF1B, LVISF2_IS	Original release
R2408	August 2024	LVISF1B, LVISF2_IS	Vertical calibration adjustment

Sample file names:

- LVISF1B_GL2022_0419_R2408_050694.h5
- LVISF2_IS_GL2022_0425_R2408_062358.TXT
- OLVIS1A_CAM020MP_GL2022_0418_R2210_039024.JPG

- OLVIS1A_CAM150MP_GL2022_0422_R2210_18-14-28.117.JPG

2.6. Greenland 2022 ICESat-2 Cal/Val

In July 2022, NASA's LVIS Facility was used to collect data over the Arctic Ocean, including along ICESat-2 Reference Ground Tracks. The LVIS-F lidar sensor was used to collect surface elevation and structure information from 10,000 m altitude on the NASA G-V airplane, along with data from as low as 500 m AGL. LVIS-F operated for a subset of the low altitude flight lines, where the primary sensor was the Leica Chiroptera-4X System operated by the University of Texas. The LVIS Canon camera (50 MP) was operated at both low and high altitudes. The LVIS Phase One camera (150 MP) was only operated at high altitude. Data on transits to/from data collection sites are also available. Note that the Level 2 data from this mission are distributed in LVIS Data Structure Version (LDS) 2.0.4 (ice surfaces), while the Level 2 data from the transits are distributed in LDS Version 2.0.3 (land surfaces).

Sample file names:

- LVISF1B_GL2022_0712_R2211_064916.h5
- LVISF2_GL2022_0707_R2212_045151.TXT (land surface)
- LVISF2_IS_GL2022_0719_R2212_061760.TXT (ice surface)
- OLVIS1A_CAM050MP_GL2022_0721_R2210_042247.JPG
  OLVIS1A_CAM150MP_GL2022_0726_R2212_20-26-14.616.JPG

2.7. Gabon 2023

Update July 2025: A new version of the LVIS-Classic data was released in July 2025 (R2507), superseding the previous release (R2309). Parameters associated with ground and canopy ranging surface detection (ZG, ZT, ZG, RHs, CHANNEL_ZT, CHANNEL_ZG, CHANNEL_RH) have been adjusted and additional lower-quality data identified and removed.

In May 2023, NASA's LVIS Facility was used to collect data over Gabon, Africa and neighboring countries. Two LVIS lidars and one camera were operated on the NASA LaRC Gulfstream-III aircraft. Science targets included sections of GEDI reference ground tracks, areas where complementary ground and airborne-based data collections exist, and LVIS data collection sites flown previously as part of the 2016 AfriSAR campaign. Sections of LVIS data collection areas were also flown by the DLR FSAR sensor during the same time period.

LVISF Product Release History

Release	Date	Products	Description
R2309	September 2023	LVISC1B, LVISC2	Original release
R2507	July 2025	LVISC1B, LVISC2	Surface detection adjustment

Sample file names:

- LVISC1B_Gabon2023_0525_R2507_064270.h5
- LVISC2_Gabon2023_0525_R2507_064270.TXT
- OLVIS1A_CAM150MP_Gabon2023_0529_R2305_14-47-50.513.JPG

2.8. BioSCape 2023

In October/November 2023, NASA's LVIS Facility flew as a part of the Biodiversity Survey of the Cape (BioSCape) mission, an international collaboration between NASA and several organizations in South Africa to study biodiversity in South Africa's Greater Cape Floristic Region. Sixteen science flights were flown over ground targets identified by the BioSCape project to highlight the region's biodiversity and study the region's ecosystems to help address the information and decision-support needs of stakeholders in the region and internationally.

The primary data collection was from ~7km above ground level on the NASA G-V airplane, however sections of data were collected from lower altitudes. The range parameter can be used to determine flight altitude. The Level 2 data from this mission are distributed in LVIS Data Structure Version (LDS) 2.0.5 which includes two alternate ground elevations options in order to provide flexibility for local site conditions; if selected for use, adjust the values of the RH parameters accordingly. Please consult the User Guide for further information.

Sample file names:

- LVISF2_BioSCape2023_1031_R2404_036454.TXT
- LVISF1B_BioSCape2023_1112_R2404_050383.h5

2.9. ICESat-2 Lake Ice 2024

On February 26 and March 1, 2024, NASA's LVIS Facility flew over the the Great Lakes collecting calibration and validation data for NASA’s Ice, Cloud, and Land Elevation Satellite-2 (ICESat-2). The LVIS-F lidar sensor and two camera sensors were operated on the NASA P-3 aircraft at a nominal altitude of 7,000 m.

Sample file names:

- LVISF2_IS2LakeIce2024_0301_R2407_054622.TXT
- LVISF1B_IS2LakeIce2024_0301_R2407_054622.h5
- OLVIS1A_CAM150MP_IS2LakeIce2024_0226_R2407_15-12-14.476.JPG

2.10. ARCSIX 2024

In May-August 2024, NASA's LVIS Facility supported the Arctic Radiation Cloud Aerosol Surface Interaction Experiment (ARCSIX) on the NASA P3-B, collecting surface elevations and structure data as one of a suite of sensors flown for the two ARCSIX deployments. LVIS data was targeted for collecting from a flight altitude of 5.5 km above the surface, however best-effort data was also collected down to altitudes as low as 500 m during the flights. The LVIS-F and two camera sensors were installed for the flights. Note that because of the various flight altitudes, collection parameters of the LVIS lidar and cameras vary (see mission information tables below for further details).

Sample file names:

- OLVIS1A_CAM150MP_ARCSIX2024_0517_R2411_82012_8.JPG

- OLVIS1A_CAM020MP_ARCSIX2024_0605_R2412_051348_0.JPG
- OLVIS1A_CAM050MP_ARCSIX2024_0729_R2412_040910_2.JPG

2.11. SARP 2024

In summer 2024, NASA's LVIS Facility supported the Student Airborne Research Program (SARP) on the NASA P3-B, collecting surface elevations and structure data over sites on the US East and West Coasts. LVIS-F and two camera sensors were installed for the flights.

Sample file names:

- LVISF1B_SARP2024_0701_R2503_073287.h5
- LVISF2_SARP2024_0702_R2503_060397.TXT
- OLVIS1A_CAM150MP_SARP2024_0702_R2411_58668_7.JPG
- OLVIS1A_CAM020MP_ARCSIX2024_0605_R2412_049013_1.JPG

3. Other LVIS Datasets

Many other LVIS datasets are available at NSIDC as part of wider campaign collections such as Operation IceBridge (OIB) from 2009 to 2017, AfriSAR in 2016, and AboVE in 2017. Details on the missions and data types can be found at the links provided below.

Campaign	Product	Years	LVISdataID	Documentation
OIB	Level 1A	2009-2017	IOLVIS1A	https://nsidc.org/data/iolvis1a/versions/1
OIB	Level 1B	2009-2017	ILVIS1B	https://nsidc.org/data/ilvis1b/versions/2
OIB	Level 2	2009-2015	ILVIS2	https://nsidc.org/data/ilvis2/versions/1
OIB	Level 2	2017	ILVIS2	https://nsidc.org/data/ilvis2/versions/2
AfriSAR	Level 1A	2016	AFOLVIS1A	https://nsidc.org/data/afolvis1a/versions/1
AfriSAR	Level 1B	2016	AFLVIS1B	https://nsidc.org/data/aflvis1b/versions/1
AfriSAR	Level 2	2016	AFLVIS2	https://nsidc.org/data/aflvis2/versions/1
ABoVE	Level 1A	2017	ABOLVIS1A	https://nsidc.org/data/abolvis1a/versions/1
ABoVE	Level 1B	2017	ABLVIS1B	https://nsidc.org/data/ablvis1b/versions/1
ABoVE	Level 2	2017	ABLVIS2	https://nsidc.org/data/ablvis2/versions/1

Note: LVIS originally provided raw images as part of the Operation IceBridge datasets. These images are now being georeferenced and released as Level 1A products as they become available.

4. File Naming Convention

4.1. LVIS Lidar Instruments

LVISdataID_CampaignYYYY_MMDD_RYYMM_nnnnnn.ext

String	Description
LVISdataID	Dataset ID (see table below)
Campaign	Campaign name (ex: ABoVE, GEDI) or primary location (ex: US, GL)
YYYY	Four-digit year of campaign
MMDD	Two-digit month, two-digit day of start of data collection
RYYMM	Date (YY year / MM month) of the data production
nnnnnn	Number of seconds since GPS midnight of the day the data collection started
ext	File extension: .h5 (L1B), .TXT (L2), .JPG or .CR2 (L1A)

Dataset ID:

LVISdataID	Description
LVISF1B	LVIS-Facility Level 1B (geolocated laser return vector)
LVISF2	LVIS-Facility Level 2 (surface elevation, height and other parameters derived from the geolocated laser return vector). Note: LVISF2_IS is part of the LVISF2 dataset, containing data fields relevant to “ice surfaces”
LVISC1B	LVIS-Classic Level 1B (geolocated laser return vector)
LVISC2	LVIS-Classic Level 2 (surface elevation, height and other parameters derived from the geolocated laser return vector)

4.2. LVIS Cameras Released Before October 2024

Camera images released on or **before October 2024 (R2410)** had a different format depending on the individual camera.

4.2.1. Canon Cameras

OLVIS1A_CameraID_CampaignYYYY_MMDD_RYYMM_nnnnnn.ext

String	Description
OLVIS1A_CameraID	LVIS-Camera with camera identifier (geotagged downlooking photos taken during a flight)
Campaign	Campaign name (ex: ABoVE, GEDI) or primary location (ex: US, GL)
YYYY	Four-digit year of campaign
MMDD	Two-digit month, two-digit day of start of data collection
RYYMM	Date (YY year / MM month) of the data production
nnnnnn	Number of seconds since GPS midnight of the day the data collection started
ext	File extension: .JPG or .CR2 (L1A)

4.2.2. Phase One Camera

The Phase One iXM-RS150F camera system (dataset ID: OLVIS1A_150MP) was added to the instrument suite in 2022 and has a slightly different naming convention for releases before October 2024. The times of data collection are UTC.

OLVIS1A_CAM150MP_CampaignYYYY_MMDD_RYYMM_hh-mm-ss.sss.JPG

String	Description
OLVIS1A_CAM150MP	Dataset ID
Campaign	Campaign name (ex: ABoVE, GEDI) or primary location (ex: US, GL)
YYYY	Four-digit year of campaign
MMDD	Two-digit month, two-digit day of start of data collection
RYYMM	Date (YY year / MM month) of the data production
hh-mm-ss.sss	**UTC time** of data collection in 2-digit hours, 2-digit minutes, 2-digit seconds, and 3-digit milliseconds

4.3. LVIS Cameras Released After October 2024

The file naming convention for camera data released **on or after November 2024 (R2411)** has been unified across all cameras and the times are now all in **GPS time**. A decimal second has also been added.

OLVIS1A_CameraID_CampaignYYYY_MMDD_RYYMM_nnnnnn_p.ext

String	Description
OLVIS1A_CameraID	LVIS-Camera with camera identifier (geotagged downlooking photos taken during a flight)
Campaign	Campaign name (ex: ABoVE, GEDI) or primary location (ex: US, GL)
YYYY	Four-digit year of campaign
MMDD	Two-digit month, two-digit day of the data collection
RYYMM	Date (YY year / MM month) of the data production
nnnnnn	Number of seconds since **GPS** midnight of the day of the data collection
p	Decimal second
ext	File extension: .JPG or .CR2 (L1A)

5. Mission-Specific Information

5.1. United States 2018-2019 (US2018, US2019)

5.1.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Camera
Flight Platform	NASA LaRC Beechcraft B-200 King Air
Nominal Flight Altitude	8,500 m
Dates	2018-11-07 to 2019-01-31
Campaign File Name	US2018, US2019
Primary Targeted Areas	Southeastern United States
Geographical Extent	281-285 E, 34-39 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/US2018Map.html

5.1.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility	LVIS-Classic
Nominal Footprint Diameter	7 m (0.75 mrad)	not flown
Nominal Swath Width	1.7 km (200 mrad)	not flown
LVISdataID	LVISF1B, LVISF2	not flown
Data Format Version	2.0.3	not flown

5.1.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera1	LVIS-Camera2
Camera Model	Canon EOS 5DS R	not flown
Lens Model	Carl Zeiss Planar T* 85mm f/1.4 ZE	not flown
Image Resolution	8688 x 5792 pixel (50 MPixel)	not flown
Nominal Resolution	3.6 km x 2.4 km (0.4 m/pixel)	not flown
Nominal Overlap	77%	not flown
LVISdataID	OLVIS1A_CAM1	not flown

5.1.4. Install-Specific Notes

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISC1B	LVISC2	CAM1	CAM2
2018-11-07	30	30	-	-	2367	-
2019-01-31	113	113	-	-	4087	-
Total	143	143	-	-	6454	-

5.1.5. Known Issues

None

5.1.6. Acknowledgments

This work was supported through funding from NASA.

5.2. GEDI 2019 (GEDI2019)

5.2.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Classic, LVIS-Camera1, LVIS-Camera2
Flight Platform	NASA JSC Gulfstream V
Nominal Flight Altitude	13,000 m
Dates	2019-05-21 to 2019-06-04
Campaign File Name	GEDI2019
Primary Targeted Areas	Southern United States and Costa Rica
Geographical Extent	236-279 E, 9-38 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/GEDI2019Map.html
Campaign website	https://gedi.umd.edu/science/calibration-validation/

5.2.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility	LVIS-Classic
Nominal Footprint Diameter	10 m (0.75 mrad)	25 m (2 mrad)
Nominal Swath Width	2.5 km (200 mrad)	2.5 km (200 mrad)
LVISdataID	LVISF1B, LVISF2	LVISC1B, LVISC2
Data Format Version	2.0.3	2.0.3

5.2.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera 1	LVIS-Camera 2
Camera Model	Canon EOS 5DS R	Canon EOS 5DS R
Lens Model	Carl Zeiss Makro-Planar T* 100mm f/2 ZE	Carl Zeiss Planar T* 85mm f/1.4 ZE
Image Resolution	8688 x 5792 pixel (50 MPixel)	5792 x 8688 pixel (50 MPixel)
Nominal Resolution	4.2km x 2.8km (0.5m/pixel)	3.3km x 4.9km (0.6m/pixel)
Nominal Overlap	67%	80%
LVISdataID	OLVIS1A_CAM1	OLVIS1A_CAM2

5.2.4. Install-Specific Notes

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISC1B	LVISC2	CAM1	CAM2
2019-05-21	157	157	36	36	4118	4055
2019-05-23	193	193	41	41	4930	4917
2019-05-24	104	104	24	24	3686	3706
2019-05-29	199	199	42	42	5949	5920
2019-06-04	135	135	30	30	6397	6568
Total	788	788	173	173	25080	25166

5.2.5. Known Issues

For all LVIS-Camera images, the last six numbers in the file name refer to the time at which the picture was taken, indicating the number of seconds past GPS midnight on the day the data collection started. This information can also be found in the Exif data for each file under the "GPS Date/Time" field. Due to a formatting error, a 1-second offset may exist in the image collection time contained in the Exif "GPS Date/Time" field. The affected flights are listed below. For images from these flights, the collection time contained in the file name should be used, or one second should be added to the time contained in the Exif "GPS Date/Time" field

Date	Cameras affected
2019-05-21	Camera 2
2019-05-23	Camera 1
2019-05-24	Camera 1 and Camera 2
2019-05-29	Camera 1 and Camera 2
2019-06-04	None

5.2.6. Acknowledgments

This work was supported through funding from NASA. GEDI flights were supported by the GEDI mission.

5.3. ABoVE 2019 (ABoVE2019)

5.3.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Classic, LVIS-Camera1, LVIS-Camera2
Flight Platform	NASA JSC Gulfstream V
Nominal Flight Altitude	13,000 m
Dates	2019-07-12 to 2019-08-07
Campaign File Name	ABoVE2019
Primary Targeted Areas	Canada and Alaska
Geographical Extent	192-266 E, 28-72 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/ABoVE2019Map.html
Campaign website	https://above.nasa.gov/index.html

5.3.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility	LVIS-Classic
Nominal Footprint Diameter	10 m (0.75 mrad)	25 m (2 mrad)
Nominal Swath Width	2.5 km (200 mrad)	2.5 km (200 mrad)
LVISdataID	LVISF1B, LVISF2	LVISC1B, LVISF2
Data Format Version	2.0.3	2.0.3

5.3.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera 1	LVIS-Camera 2
Camera Model	Canon EOS 5DS R	Canon EOS 5DS R
Lens Model	Carl Zeiss Makro-Planar T* 100mm f/2 ZE	Carl Zeiss Planar T* 85mm f/1.4 ZE
Image Resolution	8688 x 5792 pixel (50 MPixel)	5792 x 8688 pixel (50 MPixel)
Nominal Resolution	4.2km x 2.8km (0.5m/pixel)	3.3km x 4.9km (0.6m/pixel)
Nominal Overlap	67%	80%
LVISdataID	OLVIS1A_CAM1	OLVIS1A_CAM2

5.3.4. Install-Specific Notes

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISC1B	LVISC2	CAM1	CAM2
2019-07-12	203	203	45	45	6306	6231
2019-07-13	86	86	18	18	4793	4754
2019-07-15	118	118	27	27	5194	5197
2019-07-16	170	170	37	37	7487	7487
2019-07-18	106	106	22	22	4733	4733
2019-07-22	225	225	49	49	7138	7121
2019-07-23	100	100	22	22	3939	3912
2019-07-25	108	108	25	25	5877	5801
2019-07-27	46	46	12	12	3182	3178
2019-07-28	76	76	18	18	4842	4846
2019-07-29	110	110	25	25	5871	5848
2019-07-31	134	134	30	30	5892	5856
2019-08-01	118	118	27	27	5336	5336
2019-08-07	140	140	32	32	2284	2285
Total	1740	1740	389	389	72874	72585

5.3.5. Known Issues

For all LVIS-Camera images, the last six numbers in the file name refer to the time at which the picture was taken, indicating the number of seconds past GPS midnight on the day the

data collection started. This information can also be found in the Exif data for each file under the "GPS Date/Time" field. Due to a formatting error, a 1-second offset may exist in the image collection time contained in the Exif "GPS Date/Time" field. The affected flights are listed below. For images from these flights, the collection time contained in the file name should be used, or one second should be added to the time contained in the Exif "GPS Date/Time" field

Date	Cameras affected
2019-07-12	Camera 1 and Camera 2
2019-07-13	None
2019-07-15	None
2019-07-16	None
2019-07-18	None
2019-07-22	Camera 1 and Camera 2
2019-07-23	Camera 1
2019-07-25	Camera 1 and Camera 2
2019-07-27	Camera 1 and Camera 2
2019-07-28	Camera 1 and Camera 2
2019-07-29	None
2019-07-31	Camera 1 and Camera 2
2019-08-01	None
2019-08-07	None

5.3.6. Acknowledgments

This work was supported through funding from NASA. ABoVE flights were supported by Hank Margolis (NASA - SMD - ESD Terrestrial Ecology).

5.4. GEDI 2021 (GEDI2021)

5.4.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Classic, LVIS-Camera1, LVIS-Camera2
Flight Platform	NASA JSC Gulfstream V
Nominal Flight Altitude	13,000 m (US) and 10,000 m (French Guiana)
Dates	2021-07-16 to 2021-08-06
Campaign File Name	GEDI2021
Primary Targeted Areas	United States and French Guiana
Geographical Extent	262-309 E, 2-45 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/GEDI2021Map.html
Campaign website	https://gedi.umd.edu/science/calibration-validation/

5.4.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility	LVIS-Classic
Nominal Footprint Diameter	10 m (US) and 8 m (French Guiana) (0.75 mrad)	25 m (US) and 20 m (French Guiana) (2 mrad)
Nominal Swath Width	2.5 km (US), 2 km (French Guiana) (200 mrad)	2.5 km (US), 2 km (French Guiana) (200 mrad)
LVISdataID	LVISF1B, LVISF2	LVISC1B, LVISC2
Data Format Version	2.0.3	2.0.3

5.4.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera 1	LVIS-Camera 2
Camera Model	Canon EOS 5DS R	Canon EOS 5DS R
Lens Model	Carl Zeiss Makro-Planar T* 100mm f/2 ZE	Carl Zeiss Planar T* 85mm f/1.4 ZE
Image Resolution	8688 x 5792 pixel (50 MPixel)	5792 x 8688 pixel (50 MPixel)
Nominal Resolution	4.2 km x 2.8 km (0.5 m/pixel)	3.3 km x 4.9 km (0.6 m/pixel)
Nominal Overlap	67%	80%
LVISdataID	OLVIS1A_CAM1	OLVIS1A_CAM2

5.4.4. Install-Specific Notes

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISC1B	LVISC2	CAM1	CAM2
2021-07-16	0	0	0	0	2011	2128
2021-07-19	46	46	11	11	2685	2891
2021-07-20	137	137	29	29	5244	5274
2021-07-23	109	109	36	36	10052	10095
2021-07-27	136	136	23	23	10564	10721
2021-07-29	105	105	27	27	9935	9935
2021-07-31	102	102	27	27	9207	9217
2021-08-01	59	59	15	15	4025	3941
2021-08-05	125	125	31	31	8929	8929
2021-08-06	220	220	48	48	10841	10842
Total	1039	1039	247	247	73493	73973

Some flights included multiple targeted altitudes and footprint size. Flights can be assumed to be at nominal altitude except for sections noted below:

Date	Start time	End time	Altitude	Location
2021-07-29	54150 s	56090 s	7,400 m	French Guiana
2021-07-29	61470 s	63500 s	7,400 m	French Guiana
2021-08-05	59630 s	60810 s	7,400 m	Coweeta (US)

Instrument at 7,400 m	LVIS-Facility	LVIS-Classic
Footprint Diameter	6 m (0.75 mrad)	15 m (2 mrad)
Swath Width	1.5 km (200 mrad)	1.5 km (200 mrad)

5.4.5. Known Issues

None

5.4.6. Acknowledgments

These flights were supported by funding from the GEDI mission.

5.5. Greenland 2022 Spring (GL2022_04)

5.5.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Camera1, LVIS-Camera2
Flight Platform	NASA WFF P-3B Orion
Nominal Flight Altitude	500 m AGL; 7,000 m
Dates	2022-04-12 to 2022-04-27
Campaign File Name	GL2022_04
Primary Targeted Areas	Greenland and Arctic Ocean
Geographical Extent	258-332 E, 37-87 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/GN202204Map.html
Campaign website	https://ae.ku.edu/cresis

5.5.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility at 500 m AGL	LVIS-Facility at 7000 m
Nominal Footprint Diameter	1 m (2.136 mrad)	15 m (2.136 mrad)
Nominal Swath Width	80 m (150 mrad)	1.4 km (200 mrad)
LVISdataID	LVISF1B, LVISF2_IS	LVISF1B, LVISF2_IS
Data Format Version	2.0.3 (L1B), 2.0.4 (L2)	2.0.3 (L1B), 2.0.4 (L2)

5.5.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera 1	LVIS-Camera 2
Camera Model	Phase One iXM-RS150F	Canon EOS 5D Mk II
Lens Model	Rodenstock 180 mm	Carl Zeiss Distagon T* 28mm f/2 ZE
Image Resolution	14,204 x 10,652 pixel (150 MPixel)	5,616 x 3,744 pixel (21 MPixel)
Nominal Resolution	2.1 km x 1.4 km (15 cm/pixel)	600 m x 400 m (10 cm/pixel)

Nominal Overlap	67%	67%
LVISdataID	LVIS_CAM150MP	LVIS_CAM020MP

5.5.4. Install-Specific Notes

Campaign included install and operation of a newly-acquired Phase One iXM-RS150F camera system. It was primarily operated on high-altitude portions of flights and data from this sensor (dataset ID: OLVIS1A_CAM150MP) should be considered experimental.

The Canon camera (OLVIS1A_CAM20MP) was operating on all flights including test flights (2022-04-12) and transits (2022-04-18, 2022-04-27).

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2_IS	LVISC1B	LVISC2	CAM150MP	CAM020MP
2022-04-12	-	-	-	-	-	4249
2022-04-18	-	-	-	-	-	8183
2022-04-19	178	178	-	-	-	9947
2022-04-21	159	159	-	-	5709	3206
2022-04-22	192	192	-	-	-	16277
2022-04-25	171	171	-	-	8277	3184
2022-04-27	-	-	-	-	-	2835
Total	700	700			13986	47934

Operating altitude on science flights:

Date	Details
2022-04-19	Flight was primarily designed for low altitude operations (500 m above the surface) but included initial transit at high altitude. Low altitude operations began approximately around 52300 s.
2022-04-21	High-altitude flight with Phase One camera operating.
2022-04-22	Flight was primarily designed for low altitude operations (500 m above the surface) but included final transit at high altitude. Low altitude operations ended approximately around 62000 s.
2022-04-25	High-altitude flight with Phase One camera operating.

5.5.5. Known Issues

None

5.5.6. Acknowledgments

This work was supported through funding from NASA.

5.6. Greenland 2022 ICESat-2 Cal/Val (GL2022_07)

5.6.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Camera1 and LVIS-Camera2
Flight Platform	NASA JSC Gulfstream V
Nominal Flight Altitude	10,000 m
Dates	2022-07-01 to 2022-07-27
Campaign File Name	GL2022_07
Primary Targeted Areas	Arctic Ocean
Geographical Extent	-105 to 22 E, 25-88 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/GN202207Map.html
Campaign website	https://icesat-2.gsfc.nasa.gov/pages/lvis-summer-2022-lidar-data

5.6.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility at 10,000 m
Nominal Footprint Diameter	12 m (1.27 mrad)
Nominal Swath Width	2 km (200 mrad)
LVISdataID	LVISF1B, LVISF2, LVISF2_IS
Data Format Version	2.0.3 (L1B), 2.0.3 (L2 land surfaces), 2.0.4 (L2 ice surfaces)

Note: Low-altitude operation of the LVISF sensor was not requested by the Science Team, however, the sensor was used to collect data and provided as-is. Nominal parameters for during the low altitude operations were:

Instrument	LVIS-Facility at 500 m AGL
Nominal Footprint Diameter	1 m (1.27 mrad)
Nominal Swath Width	80 m (200 mrad)
LVISdataID	LVISF1B, LVISF2_IS
Data Format Version	2.0.3 (L1B), 2.0.4 (L2 ice surfaces)

5.6.3. LVIS Camera Instruments Flown

Instrument	Camera 1	Camera 2	
Camera Model	Phase One iXM-RS150F	Canon EOS 5DS R	
Lens Model	Rodenstock 180 mm	Carl Zeiss Distagon T* 28mm f/2 ZE	
Image Resolution	14,204 x 10,652 pixel (150 Mpixel)	5,792 x 8,688 pixel (50 MPixel)	
Nominal Resolution	Altitude: 10,000 m	10,000 m	500 m
	3 km x 2 km (20 cm/pixel)	5.6 km x 8.4 km (144 x 64 cm/pixel)	260 m x 390 m (7 x 3 cm/pixel)
Nominal Overlap	67%	67%	
LVISdataID	LVIS_CAM150MP	LVIS_CAM050MP	

5.6.4. Install-Specific Notes

The Phase One iXM-RS150F camera system (dataset ID: OLVIS1A_CAM150MP) was not operated during low altitude portions of flights.

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISF2_IS	LVISC	CAM150MP	CAM050MP
2022-07-01	-	-	-	-	751	2122
2022-07-06	-	-	-	-	836	311
2022-07-07	116	116	-	-	-	2155
2022-07-11	113	-	113	-	5003	2306
2022-07-12	74	-	74	-	2872	2159
2022-07-19	87	-	87	-	2142	3584
2022-07-21	28	-	28	-	728	5168
2022-07-23	18	-	18	-	718	4975
2022-07-26	88	-	88	-	3137	4343
2022-07-27	96	96	-	-	3139	2397
Total	620	620	-	-	19326	29520

LVISF data was collected at low altitude and provided as-is for the following flights:

Date	Altitude
2022-07-21	Flight was designed for low altitude operations (500 m above the surface) but included transits at higher altitude. LVISF data collected from low altitude is between 49000 and 57000 s.
2022-07-23	Flight was designed for low altitude operations (500 m above the surface) but included transits at higher altitude. LVISF data collected from low altitude starting at 52000 s
2022-07-26	Flight includes low altitude data collection between 59700 and 62100 s before high altitude transit to the US.

5.6.5. Known Issues

None

5.6.6. Acknowledgments

This work was supported through funding from NASA.

5.7. Gabon 2023

5.7.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Classic, LVIS-Camera1
Flight Platform	NASA LaRC Gulfstream III
Nominal Flight Altitude	8,000 m
Dates	2023-5-15 to 2023-5-31
Campaign File Name	Gabon2023
Primary Targeted Areas	Gabon, Africa
Geographical Extent	-78 to 17 E, -3 to 39 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/Gabon2023Map.html

5.7.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility	LVIS-Classic
Nominal Footprint Diameter	10 m (1.27 mrad)	20 m (2.5 mrad)
Nominal Swath Width	1.5 km (200 mrad)	1.5 km (200 mrad)
LVISdataID	LVISF1B, LVISF2	LVISC1B, LVISC2
Data Format Version	2.0.3	2.0.3

5.7.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera
Camera Model	Phase One iXM-RS150F
Lens Model	Rodenstock 180 mm
Image Resolution	14,204 x 10,652 pixel (150 Mpixel)
Nominal Resolution	2.4 km x 1.6 km (16 cm/pixel)
Nominal Overlap	70%
LVISdataID	LVIS_CAM150MP

5.7.4. Install-Specific Notes

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISC1B	LVISC2	CAM150MP
2023-05-15	-	-	-	-	2942
2023-05-19	tbd	tbd	8	8	1636
2023-05-20	tbd	tbd	17	17	5014
2023-05-22	tbd	tbd	16	16	5535
2023-05-23	tbd	tbd	18	18	4492
2023-05-24	tbd	tbd	26	26	3645
2023-05-25	tbd	tbd	24	24	4089
2023-05-27	tbd	tbd	14	14	3151
2023-05-29	tbd	tbd	8	8	3160

2023-05-30	tbd	tbd	18	18	3881
2023-05-31	tbd	tbd	16	16	4301
Total	tbd	tbd	165	165	41846

5.7.5. Known Issues

5.7.6. Acknowledgments

This work was supported by funding from NASA.

5.8. BioSCape 2023

5.8.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Camera1 and LVIS-Camera2
Flight Platform	NASA JSC Gulfstream V
Nominal Flight Altitude	7,000 m; 5,000 m
Dates	2023-10-20 to 2023-11-15
Campaign File Name	BioSCape2023
Primary Targeted Areas	South Africa
Geographical Extent	17 to 27 E, 35 to 31 S
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/SouthAfrica2023Map.html
Campaign website	https://www.bioscape.io/

5.8.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility at 7,000 m	LVIS-Facility at 5,000 m
Nominal Footprint Diameter	8 m (1.16 mrad)	6 m
Nominal Swath Width	1.1 km (164 mrad)	0.9 km (180 mrad)
LVISdataID	LVISF1B, LVISF2	LVISF1B, LVISF2
Data Format Version	2.0.3 (L1B), 2.0.5 (L2)	2.0.3 (L1B), 2.0.5 (L2)

5.8.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera1	LVIS-Camera2
Camera Model	Phase One iXM-RS150F	Canon EOS 5DS R
Lens Model	Rodenstock 180 mm	Carl Zeiss Distagon T* 28mm f/2 ZE
Image Resolution	14,204 x 10,652 pixel (150 MPixel)	5,792 x 8,688 pixel (50 MPixel)

Nominal Resolution	2.1 km x 1.4 km (15 cm/pixel)	1.6 km x 1.1 km (30 cm/pixel)
Nominal Overlap	67%	67%
LVISdataID	LVIS_CAM150MP	LVIS_CAM050MP

5.8.4. Install-Specific Notes

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISC1B	LVISC2	CAM150MP	CAM050MP
2023-10-20	78	78	-	-	5292	4343
2023-10-22	183	183	-	-	10080	8059
2023-10-25	164	164	-	-	10031	8247
2023-10-26	144	144	-	-	10135	8147
2023-10-28	91	91	-	-	6752	5442
2023-10-29	107	107	-	-	7926	6428
2023-10-30	161	161	-	-	10894	8923
2023-10-31	100	100	-	-	6443	5466
2023-11-01	88	88	-	-	5280	4756
2023-11-05	190	190	-	-	9940	9046
2023-11-08	179	179	-	-	8888	7977
2023-11-09	193	193	-	-	9117	8684
2023-11-10	211	211	-	-	9512	9597
2023-11-12	158	158	-	-	7765	7123
2023-11-13	152	152	-	-	6269	-
2023-11-15	129	129	-	-	6893	6355
Total	2328	2328	-	-	131286	108593

5.8.5. Known Issues

5.8.6. Acknowledgments

5.9. ICESat-2 Lake Ice 2024

5.9.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Camera1 and LVIS-Camera2
Flight Platform	NASA WFF P-3B Orion
Nominal Flight Altitude	7,000 m
Dates	February 26 and March 1, 2024
Campaign File Name	IS2LakeIce2024
Primary Targeted Areas	Great Lakes
Geographical Extent	276 to 285 E, 37 to 47 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/USLakeIce2024Map.html

5.9.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility
Nominal Footprint Diameter	16 m (1.16 mrad)
Nominal Swath Width	1.4 km (200 mrad)
LVISdataID	LVISF1B, LVISF2_IS
Data Format Version	2.0.3 (L1B), 2.0.4 (L2 ice surfaces)

5.9.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera 1	LVIS-Camera 2
Camera Model	Phase One iXM-RS150F	Canon EOS 5D Mk II
Lens Model	Rodenstock 180 mm	Carl Zeiss Makro-Planar 2/100 ZE
Image Resolution	14,204 x 10,652 pixel (150 MPixel)	5,616 x 3,744 pixel (21 MPixel)
Nominal Resolution	2.1 km x 1.4 km (15 cm/pixel)	1.6 km x 1.1 km (30 cm/pixel)
Nominal Overlap	67%	67%
LVISdataID	LVIS_CAM150MP	LVIS_CAM020MP

5.9.4. Install-Specific Notes

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISC1B	LVISC2	CAM150MP	CAM020MP
2024-02-26	18	18	-	-	7700	6561
2024-03-01	33	33	-	-	6667	7431
Total	51	51	-	-	14367	13992

5.9.5. Known Issues

Leaking jet fuel over the LVIS view port during the flight on February 26 caused varying levels of surface obscuration throughout the flight. Camera imagery from this flight may show partial obscuration of the surface as a result. The leak was fixed prior to the flight on March 1.

5.9.6. Acknowledgments

5.10. ARCSIX 2024

5.10.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Camera1 and LVIS-Camera2
Flight Platform	NASA WFF P-3B Orion
Nominal Flight Altitude	5,500 m
Dates	2024-05-17 to 2024-08-16
Campaign File Name	ARCSIX2024
Primary Targeted Areas	Greenland and Arctic Ocean
Geographical Extent	254 to 352 E, 34 to 87 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/GN2024Map.html
Campaign website	https://espo.nasa.gov/arcsix

5.10.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility
Nominal Footprint Diameter	6 m (1.16 mrad)
Nominal Swath Width	1.1 km (200 mrad)
LVISdataID	LVISF1B, LVISF2_IS
Data Format Version	2.0.3 (L1B), 2.0.4 (L2 Ice Surfaces)

5.10.3. LVIS Camera Instruments Flown

The time interval between camera shots is controlled in flight, but varies based on the altitude and speed of the plane.

Instrument	LVIS-Camera1	LVIS-Camera2	LVIS-Camera2
Dates	2024-05-17 to 2024-08-16	2024-05-17 to 2024-06-17	2024-07-22 to 2024-08-16
Camera Model	Phase One iXM-RS150F	Canon EOS 5D Mk II	Canon EOS 5DS R
Lens Model	Rodenstock 180 mm	Canon EF 28mm f/1.8	Canon EF 28mm f/1.8
Image Resolution	14,204 x 10,652 pixel (150 MPixel)	5,616 x 3,744 pixel (21 MPixel)	5,792 x 8,688 pixel (50 MPixel)
Nominal Resolution at 5,500 m AGL	1.6 km x 1 km (0.12 m/pixel)	7.1 km x 4.7 km (1.25 m/pixel)	7.1 km x 4.7 km (0.81 m/pixel)
Nominal Resolution at 500 m AGL	-	650 m x 430 m (0.11 m/pixel)	650 m x 430 m (0.07 m/pixel)
Nominal Overlap	67%	67%	67%
LVISdataID	LVIS_CAM150MP	LVIS_CAM020MP	LVIS_CAM050MP

5.10.4. Install-Specific Notes

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2_IS	LVISC1B	LVISC2	CAM150MP	CAM020MP	CAM050MP
2024-05-17	-	-	-	-	36	2158	-
2024-05-21	-	-	-	-	469	1355	-
2024-05-24	-	-	-	-	2297	2073	-
2024-05-28	39	39	-	-	6322	1750	-
2024-05-30	37	37	-	-	1082	4805	-
2024-05-31	104	104	-	-	3751	12026	-
2024-06-03	10	10	-	-	248	2762	-
2024-06-05	88	88	-	-	2699	17166	-
2024-06-06	102	102	-	-	4980	13707	-
2024-06-07	46	46	-	-	1671	8335	-
2024-06-10	22	22	-	-	201	7290	-
2024-06-11	94	94	-	-	4464	16433	-
2024-06-13	66	66	-	-	2987	27153	-
2024-06-17	-	-	-	-	2473	1748	-
2024-07-22	-	-	-	-	7	-	2085
2024-07-25	31	31	-	-	1999	-	9846
2024-07-29	69	69	-	-	5799	-	13130
2024-07-30	114	114	-	-	3655	-	7388
2024-08-01	98	98	-	-	2655	-	9177
2024-08-02	119	119	-	-	6874	-	8599
2024-08-07	30	30	-	-	2844	-	11105
2024-08-08	88	88	-	-	2309	-	12639
2024-08-09	30	30	-	-	3233	-	12768
2024-08-15	66	66	-	-	5027	-	8159
2024-08-16	-	-	-	-	2878	-	3342
Total	1254	1254	-	-	70960	118761	98238

5.10.5. Known Issues

5.10.6. Acknowledgments

5.11. SARP 2024

5.11.1. Mission Information

Instruments Flown	LVIS-Facility, LVIS-Camera1 and LVIS-Camera2
Flight Platform	NASA WFF P-3B Orion
Nominal Flight Altitude	7,000 m
Dates	2024-06-26 to 2024-07-03
Campaign File Name	SARP2024
Primary Targeted Areas	US East and West Coasts
Geographical Extent	239 to 285 E, 33 to 39 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/US2024Map.html
Campaign website	https://espo.nasa.gov/archive_sarp_2024

5.11.2. LVIS Lidar Instruments Flown

Instrument	LVIS-Facility
Nominal Footprint Diameter	8 m (1.16 mrad)
Nominal Swath Width	1.1 km (200 mrad)
LVISdataID	LVISF1B, LVISF2
Data Format Version	2.0.3

5.11.3. LVIS Camera Instruments Flown

Instrument	LVIS-Camera 1	LVIS-Camera 2
Camera Model	Phase One iXM-RS150F	Canon EOS 5D Mk II
Lens Model	Rodenstock 180 mm	Canon EF 28mm f/1.8
Image Resolution	14,204 x 10,652 pixel (150 MPixel)	5,616 x 3,744 pixel (21 MPixel)
Nominal Resolution	1.6 km x 1 km (0.15 m/pixel)	7.1 km x 4.7 km (1.6 m/pixel)
Nominal Overlap	67%	67%
LVISdataID	LVIS_CAM150MP	LVIS_CAM020MP

5.11.4. Install-Specific Notes

The maximum size of the swath is 1.1 km, but during operations the swath width was varied to account for altitude and speed of the plane.

Number of Science Files per Flight Day:

Date	LVISF1B	LVISF2	LVISC1B	LVISC2	CAM150MP	CAM020MP
2024-06-26	44	44	-	-	4186	1683

2024-06-27	-	-	-	-	368	2641
2024-07-01	62	62	-	-	4176	2999
2024-07-02	28	28	-	-	1754	3359
2024-07-03	-	-	-	-	74	2139
Total	134	134	-	-	10558	12821

5.11.5. Known Issues

LVIS-F experienced instrumentation issues during the SARP flights. Energy levels over land surfaces were unable to be optimized due to an issue with a component controlling the amount of received laser energy entering the system. This resulted in return signal levels that were either lower than ideal or higher such that they saturated the detector and distorted the return waveform.

5.11.6. Acknowledgments

6. Historical Campaign Data Rerelease

Historical LVIS campaigns refer to a rerelease of LVIS data collected prior to 2010 in data formats similar to those used in Facility campaigns, with the addition of a variable containing the date of the data collection (see Appendix A – LVIS Data Structure 1.05).

6.1. Naming Convention

LVISdataID_CampaignYYYY[_MMDD]_RYYMM.ext

String	Description
LVISdataID	Dataset ID (see table below)
Campaign	Primary location of campaign (ex: CostaRica, Panama, CA, VA, NH)
YYYY	Four-digit year of campaign
[MMDD]	Optional. If present: Two-digit month, two-digit day of data collection
RYYMM	Date (YY year / MM month) of the data production
ext	File extension: .h5 (L1B) or .TXT (L2)

Dataset ID:

LVISdataID	Description
LVISC1B	LVIS-Classic Level 1B (geolocated laser return vector)
LVISC2	LVIS-Classic Level 2 (surface elevation, height and other parameters derived from the geolocated laser return vector)

6.2. Costa Rica & Panama 1998

In March 1998 LVIS collected data in Costa Rica focusing on the La Selva Biological Research Station. The flights were on March 15, 19, 20, 21, 28, and 31, 1998. The data are combined into a single file per data product:

- LVISC1B_CostaRica1998_R0808.h5
- LVISC2_CostaRica1998_R0808.TXT

LVIS also collected data on March 29, 1998 in Panama over Barro Colorado Island:

- LVISC1B_Panama1998_R0801.h5
- LVISC2_Panama1998_R0801.TXT

Flight Platform	NASA C-130Q
Nominal Flight Altitude	8500 m
Dates	1998-03-15 to 1998-03-31
Campaign File Name	CostaRica_March1998, Panama_March1998
Primary Targeted Areas	La Selva, Barro Colorado Island
Geographical Extent	275.8-276.2 E, 9.9-10.5 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/CR1998Map.html
Nominal Footprint Diameter	25 m
Nominal Swath Width	1.7 km
LVISdataID	LVISC1B, LVISC2
Data Format Version	1.05

Please be aware that LVIS data collected in Costa Rica and Panama in 1998 were collected using an early version of the LVIS instrument. Sections of the data may have unexpected (10m+) horizontal geolocation issues associated with beam deviations.

6.3. United States 1999

In September-October 1999 LVIS collected data over California, New Hampshire, and North Carolina:

- LVISC2_CA1999_R0701.TXT, LVISC1B_CA1999_R0701.h5
- LVISC2_NC1999_R0604.TXT, LVISC1B_NC1999_R0604.h5
- LVISC2_NH1999_R0604.TXT, LVISC1B_NH1999_R0604.h5

Flight Platform	NASA C-130Q
Nominal Flight Altitude	8500 m
Dates	1999-09-26 to 1999-10-19
Campaign File Name	CA1999, NC1999, NH1999
Primary Targeted Areas	US East/West Coasts
Geographical Extent	240-290 E, 34-45 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/ USA1999Map.html

Nominal Footprint Diameter	25 m
Nominal Swath Width	1.7 km
LVISdataID	LVISC1B, LVISC2
Data Format Version	1.05

Please be aware that LVIS data collected in California, New Hampshire and North Carolina in 1999 were collected using an early version of the LVIS instrument. Sections of the data may have unexpected (10m+) horizontal geolocation issues associated with beam deviations.

6.4. Arkansas 2006

In June 2006 LVIS collected data over Arkansas, USA. Due to file sizes, the Level2 has the entire mission whereas the Level 1B files are split into days:

- LVISC2_AR2006_R0808.TXT
- LVISC1B_AR2006_0611_R0808.h5
- LVISC1B_AR2006_0612_R0808.h5
- LVISC1B_AR2006_0613_R0808.h5
- LVISC1B_AR2006_0614_R0808.h5
- LVISC1B_AR2006_0615_R0808.h5
- LVISC1B_AR2006_0621_R0808.h5
- LVISC1B_AR2006_0622_R0808.h5

Flight Platform	DOE Beechcraft King Air B-200
Nominal Flight Altitude	8500 m
Dates	2006-06-11 to 2006-06-22
Campaign File Name	AR2006
Primary Targeted Areas	Arkansas, USA
Geographical Extent	267.3-269.2 W, 33.4-35.9 N
Flight and data locations	https://lvis.gsfc.nasa.gov/Data/Maps/USA2006Map.html
Nominal Footprint Diameter	20 m
Nominal Swath Width	1.7 km
LVISdataID	LVISC1B, LVISC2
Data Format Version	1.05

APPENDIX A – LVIS Data Structure 1.05

A release is comprised of two or more file types sharing a common origin. All files within the release have equal record numbers, and correspond to one another laser shot for shot. (i.e. record 1000 in the .h5 file will be the same laser shot as record 1000 in the .txt file for a given data set).

Note: Due to file size issues, some missions have Level2 as a single file and Level1B split into multiple files. The shots are always ordered by day and time, so concatenation of the Level 1B shots will match the Level 2 shots.

Level 1B Geolocated LVIS Waveforms (HDF format)

Item	Byte Size	Format	Units	Item Description
LFID	4	unsigned longword integer		LVIS file identification
shotnumber	4	unsigned longword integer		laser shot assigned during collection
azimuth	4	single precision floating point	degrees	true heading bearing from the instrument to the ground spot
incidentangle	4	single precision floating point	degrees	off nadir angle of the beam path
range	4	single precision floating point	meters	distance from the instrument to the ground
date	4	integer		UTC date in yyyymmdd format
time	8	double precision floating point	seconds	UTC decimal seconds of the day
lon0	8	double precision floating point	degrees	longitude of the highest sample of the waveform (degrees east)
lat0	8	double precision floating point	degrees	latitude of the highest sample of the waveform (degrees north)
z0	4	single precision floating point	meters	elevation of the highest sample of the waveform
lon431 [lon351]	8	double precision floating point	degrees	longitude of the lowest sample of the waveform (degrees east)
lat431 [lat351]	8	double precision floating point	degrees	latitude of the lowest sample of the waveform (degrees north)
z431 [z351]	4	single precision floating point	meters	elevation of the lowest sample of the waveform
Sigmean	4	single precision floating point	counts	signal mean noise level, calculated in-flight
Txwave	80	byte	counts	transmit return waveform, 8bits @ 500MHz sample spacing
Rxwave	432 [352]	byte	counts	receive return waveform, 8bits @ 500MHz sample spacing
TOTAL	1100 [940]			bytes per record

Variables and bitwidths in [brackets] are for data from 1998

Level 2 Geolocated Surface Elevation and Height Product (ASCII Text format)

Item	Byte Size	Format	Units	Item Description
LFID	4	unsigned longword integer		LVIS file identification
shotnumber	4	unsigned longword integer		laser shot assigned during collection

Date	4	integer		UTC date in yyyymmdd format
Time	8	double precision floating point	seconds	UTC decimal seconds of the day
Glon	8	double precision floating point	degrees	longitude of the lowest detected mode within the waveform (degrees east)
Glat	8	double precision floating point	degrees	latitude of the lowest detected mode within the waveform (degrees north)
zg	4	single precision floating point	meters	mean elevation of the lowest detected mode within the waveform
tlon	8	double precision floating point	degrees	longitude of the highest detected return (degrees east)
tlat	8	double precision floating point	degrees	latitude of the highest detected return (degrees north)
zt	4	single precision floating point	meters	elevation of the highest detected return (i.e., zg + rh100)
RH25	4	single precision floating point	meters	height (relative to zg) at which 25% of the waveform energy occurs
RH50	4	single precision floating point	meters	height (relative to zg) at which 50% of the waveform energy occurs
RH75	4	single precision floating point	meters	height (relative to zg) at which 75% of the waveform energy occurs
RH100	4	single precision floating point	meters	height (relative to zg) at which 100% of the waveform energy occurs
azimuth	4	single precision floating point	degrees	true heading bearing from the instrument to the ground spot
incidentangle	4	single precision floating point	degrees	off nadir angle of the beam path
range	4	single precision floating point	meters	distance from the instrument to the ground
TOTAL	84			bytes per record

APPENDIX B – LVIS Data Structure 2.0.3

A release is comprised of two or more file types sharing a common origin. All files within the release have equal record numbers, and correspond to one another laser shot for shot. (i.e. record 1000 in the .h5 file will be the same laser shot as record 1000 in the .txt file for a given data set)

Level 1B Geolocated LVIS Waveforms (HDF format)

Item	Byte Size	Format	Units	Item Description

LFID	4	unsigned longword integer		LVIS file identification
shotnumber	4	unsigned longword integer		Laser shot number assigned during collection
azimuth	4	single precision floating point	degrees	Azimuth angle of laser beam
incidentangle	4	single precision floating point	degrees	Off-nadir incident angle of laser beam
range	4	single precision floating point	meters	Distance between the instrument and the ground
time	8	double precision floating point	seconds	UTC decimal seconds of the day
lon0	8	double precision floating point	degrees	Longitude of the highest sample of the waveform (Degrees East)
lat0	8	double precision floating point	degrees	Latitude of the highest sample of the waveform (Degrees North)
z0	4	single precision floating point	meters	Elevation of the highest sample of the waveform
lon1215 [lon1023]	8	double precision floating point	degrees	Longitude of the lowest sample of the waveform (Degrees East)
lat1215 [lat1023]	8	double precision floating point	degrees	Latitude of the lowest sample of the waveform (Degrees North)
z1215 [z1023]	4	single precision floating point	meters	Elevation of the lowest sample of the waveform
sigmean	4	single precision floating point	counts	Signal mean noise level, calculated in-flight
txwave			counts	Transmitted waveform, 128 bins, 12 [10] bits @ 1GHz
rxwave			counts	Return waveform, 1216 bins, 12 [10] bits @ 1GHz

Variables and bitwidths in [brackets] are for LVIS-Classic (LVISC)

Level 2 Geolocated Surface Elevation and Height Product (ASCII Text format)

Item	Item Description
LFID	LVIS File Identification
shotnumber	Laser shot number assigned during collection
time	UTC decimal seconds of the day
glon	Longitude of the lowest detected mode within the waveform (Degrees East)
glat	Latitude of the lowest detected mode within the waveform (Degrees North)

zg	Mean elevation of the lowest detected mode within the waveform (Meters)
hlon	Longitude of the center of the highest detected mode within the waveform (Degrees East)
hlat	Latitude of the center of the highest detected mode within the waveform (Degrees North)
zh	Mean elevation of the highest detected mode within the waveform (m)
tlon	Longitude of the highest detected signal (Degrees East)
tlat	Latitude of the highest detected signal (Degrees North)
zt	Elevation of the highest detected signal (m)
RH10	Height in meters (relative to zg) at which 10% of the waveform energy occurs
RH15	Height in meters (relative to zg) at which 15% of the waveform energy occurs
RH20	Height in meters (relative to zg) at which 20% of the waveform energy occurs
RH25	Height in meters (relative to zg) at which 25% of the waveform energy occurs
RH30	Height in meters (relative to zg) at which 30% of the waveform energy occurs
RH35	Height in meters (relative to zg) at which 35% of the waveform energy occurs
RH40	Height in meters (relative to zg) at which 40% of the waveform energy occurs
RH45	Height in meters (relative to zg) at which 45% of the waveform energy occurs
RH50	Height in meters (relative to zg) at which 50% of the waveform energy occurs
RH55	Height in meters (relative to zg) at which 55% of the waveform energy occurs
RH60	Height in meters (relative to zg) at which 60% of the waveform energy occurs
RH65	Height in meters (relative to zg) at which 65% of the waveform energy occurs
RH70	Height in meters (relative to zg) at which 70% of the waveform energy occurs
RH75	Height in meters (relative to zg) at which 75% of the waveform energy occurs
RH80	Height in meters (relative to zg) at which 80% of the waveform energy occurs
RH85	Height in meters (relative to zg) at which 85% of the waveform energy occurs
RH90	Height in meters (relative to zg) at which 90% of the waveform energy occurs
RH95	Height in meters (relative to zg) at which 95% of the waveform energy occurs

RH96	Height in meters (relative to zg) at which 96% of the waveform energy occurs
RH97	Height in meters (relative to zg) at which 97% of the waveform energy occurs
RH98	Height in meters (relative to zg) at which 98% of the waveform energy occurs
RH99	Height in meters (relative to zg) at which 99% of the waveform energy occurs
RH100	Height in meters (relative to zg) at which 100% of the waveform energy occurs
azimuth	Azimuth angle of the laser beam
incidentangle	Off-nadir incident angle of the laser beam
range	Distance between the instrument and the ground
complexity	Complexity metric for the return waveform
sensitivity	Sensitivity metric for the return waveform
channel_zt	Flag indicating LVIS channel waveform contained in the Level-1B file
channel_zg	Flag indicating LVIS channel used to locate ZG
channel_rh	Flag indicating LVIS channel used to calculate RH metrics

Table B-2 Level 2

APPENDIX C – LVIS Data Structure 2.0.4

A release is comprised of two or more file types sharing a common origin. All files within the release have equal record numbers, and correspond to one another laser shot for shot. (i.e. record 1000 in the .h5 file will be the same laser shot as record 1000 in the .txt file for a given data set)

Table C-1 Level 1B

Level 1B Geolocated LVIS Waveforms (HDF format)

Item	Byte Size	Format	Units	Item Description
LFID	4	unsigned longword integer		LVIS file identification
shotnumber	4	unsigned longword integer		Laser shot number assigned during collection
azimuth	4	single precision floating point	degrees	Azimuth angle of laser beam
incidentangle	4	single precision floating point	degrees	Off-nadir incident angle of laser beam
range	4	single precision floating point	meters	Distance between the instrument and the ground
time	8	double precision floating point	seconds	UTC decimal seconds of the day

lon0	8	double precision floating point	degrees	Longitude of the highest sample of the waveform (Degrees East)
lat0	8	double precision floating point	degrees	Latitude of the highest sample of the waveform (Degrees North)
z0	4	single precision floating point	meters	Elevation of the highest sample of the waveform
lon1215 [lon1023]	8	double precision floating point	degrees	Longitude of the lowest sample of the waveform (Degrees East)
lat1215 [lat1023]	8	double precision floating point	degrees	Latitude of the lowest sample of the waveform (Degrees North)
z1215 [z1023]	4	single precision floating point	meters	Elevation of the lowest sample of the waveform
sigmean	4	single precision floating point	counts	Signal mean noise level, calculated in-flight
txwave			counts	Transmitted waveform, 128 bins, 12 [10] bits @ 1GHz
rxwave			counts	Return waveform, 1216 bins, 12 [10] bits @ 1GHz

Variables and bitwidths in [brackets] are for LVIS Classic (LVISC)

Level 2 Geolocated Surface Elevation and Height Product (ASCII Text format)

Item	Units	Item Description
LFID		LVIS File Identification
shotnumber		Laser shot number assigned during collection
time	seconds	UTC decimal seconds of the day
lon_low	degrees East	Longitude of the lowest detected mode within the waveform (Degrees East)
lat_low	degrees North	Latitude of the lowest detected mode within the waveform (Degrees North)
z_low	meters	Mean elevation of the lowest detected mode within the waveform
lon_maxamp	degrees East	Longitude of the peak mode within the waveform
lat_maxamp	degrees North	Latitude of the peak mode within the waveform
z_maxamp	meters	Mean elevation of the peak mode within the waveform
lon_high	degrees East	Longitude of the highest detected mode within the waveform

lat_high	degrees North	Latitude of the highest detected mode within the waveform
z_high	meters	Mean elevation of the highest detected mode within the waveform
lon_low_alternate	degrees East	Alternate lowest mode location, based on lower signal detection threshold
lat_low_alternate	degrees North	Alternate lowest mode location, based on lower signal detection threshold
z_low_alternate	meters	Alternate lowest mode location, based on lower signal detection threshold
azimuth	degrees	Azimuth angle of the laser beam
incidentangle	degrees	Off-nadir incident angle of the laser beam
range	meters	Distance between the instrument and the ground
complexity		Complexity metric for the return waveform
sensitivity		Sensitivity metric for the return waveform
energy1	counts	Signal return energy for channel 1
energy2	counts	Signal return energy for channel 2
energy3	counts	Signal return energy for channel 3
channel		Flag indicating LVIS channel used to extract L2 parameters

APPENDIX D – LVIS Data Structure 2.0.5

A release is comprised of two or more file types sharing a common origin. All files within the release have equal record numbers, and correspond to one another laser shot for shot. (i.e. record 1000 in the .h5 file will be the same laser shot as record 1000 in the .txt file for a given data set)

Level 1B Geolocated LVIS Waveforms (HDF format)

Item	Byte Size	Format	Units	Item Description
LFID	4	unsigned longword integer		LVIS file identification
shotnumber	4	unsigned longword integer		Laser shot number assigned during collection
azimuth	4	single precision floating point	degrees	Azimuth angle of laser beam
incidentangle	4	single precision floating point	degrees	Off-nadir incident angle of laser beam
range	4	single precision floating point	meters	Distance between the instrument and the ground
time	8	double precision floating point	seconds	UTC decimal seconds of the day

lon0	8	double precision floating point	degrees	Longitude of the highest sample of the waveform (Degrees East)
lat0	8	double precision floating point	degrees	Latitude of the highest sample of the waveform (Degrees North)
z0	4	single precision floating point	meters	Elevation of the highest sample of the waveform
lon1215 [lon1023]	8	double precision floating point	degrees	Longitude of the lowest sample of the waveform (Degrees East)
lat1215 [lat1023]	8	double precision floating point	degrees	Latitude of the lowest sample of the waveform (Degrees North)
z1215 [z1023]	4	single precision floating point	meters	Elevation of the lowest sample of the waveform
sigmean	4	single precision floating point	counts	Signal mean noise level, calculated in-flight
txwave			counts	Transmitted waveform, 128 bins, 12 [10] bits @ 1GHz
rxwave			counts	Return waveform, 1216 bins, 12 [10] bits @ 1GHz

Variables and bitwidths in [brackets] are for LVIS Classic (LVISC)

Level 2 Geolocated Surface Elevation and Height Product (ASCII Text format)

Item	Item Description
LFID	LVIS File Identification
shotnumber	Laser shot number assigned during collection
time	UTC decimal seconds of the day
glon	Longitude of the lowest detected mode within the waveform (Degrees East)
glat	Latitude of the lowest detected mode within the waveform (Degrees North)
zg	Mean elevation of the lowest detected mode within the waveform (Meters)
zg_alt1*	Mean elevation of the lowest detected mode within the waveform using alternate 1 mode detection settings
zg_alt2*	Mean elevation of the lowest detected mode within the waveform using alternate 2 mode detection settings
hlon	Longitude of the center of the highest detected mode within the waveform (Degrees East)
hlat	Latitude of the center of the highest detected mode within the waveform (Degrees North)
zh	Mean elevation of the highest detected mode within the waveform (m)
tlon	Longitude of the highest detected signal (Degrees East)

tlat	Latitude of the highest detected signal (Degrees North)
zt	Elevation of the highest detected signal (m)
RH10	Height in meters (relative to zg) at which 10% of the waveform energy occurs
RH15	Height in meters (relative to zg) at which 15% of the waveform energy occurs
RH20	Height in meters (relative to zg) at which 20% of the waveform energy occurs
RH25	Height in meters (relative to zg) at which 25% of the waveform energy occurs
RH30	Height in meters (relative to zg) at which 30% of the waveform energy occurs
RH35	Height in meters (relative to zg) at which 35% of the waveform energy occurs
RH40	Height in meters (relative to zg) at which 40% of the waveform energy occurs
RH45	Height in meters (relative to zg) at which 45% of the waveform energy occurs
RH50	Height in meters (relative to zg) at which 50% of the waveform energy occurs
RH55	Height in meters (relative to zg) at which 55% of the waveform energy occurs
RH60	Height in meters (relative to zg) at which 60% of the waveform energy occurs
RH65	Height in meters (relative to zg) at which 65% of the waveform energy occurs
RH70	Height in meters (relative to zg) at which 70% of the waveform energy occurs
RH75	Height in meters (relative to zg) at which 75% of the waveform energy occurs
RH80	Height in meters (relative to zg) at which 80% of the waveform energy occurs
RH85	Height in meters (relative to zg) at which 85% of the waveform energy occurs
RH90	Height in meters (relative to zg) at which 90% of the waveform energy occurs
RH95	Height in meters (relative to zg) at which 95% of the waveform energy occurs
RH96	Height in meters (relative to zg) at which 96% of the waveform energy occurs
RH97	Height in meters (relative to zg) at which 97% of the waveform energy occurs
RH98	Height in meters (relative to zg) at which 98% of the waveform energy occurs
RH99	Height in meters (relative to zg) at which 99% of the waveform energy occurs

RH100	Height in meters (relative to zg) at which 100% of the waveform energy occurs
azimuth	Azimuth angle of the laser beam
incidentangle	Off-nadir incident angle of the laser beam
range	Distance between the instrument and the ground
complexity	Complexity metric for the return waveform
sensitivity	Sensitivity metric for the return waveform
channel_zt	Flag indicating LVIS channel waveform contained in the Level-1B file
channel_zg	Flag indicating LVIS channel used to locate ZG
channel_rh	Flag indicating LVIS channel used to calculate RH metrics

*Note: If an alternate ground elevation is used, the RH*XX* parameter must me adjusted to reference the new ground elevation, i.e. $RHXX_{alt} = RHXX + (zg - zg_{alt})$