SnowEx Mores Creek Summit (MCS) Airborne LiDAR Survey, Version 1

USER GUIDE

How to Cite These Data

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

Ciafone, S., S. O'Neel, N. Adebisi, K. Zikan, J. Enterkine, T. Van Der Weide, Y. Wadhwani, B. Wilder, Z. Hoppinen, D. Filiano, and H.P. Marshall. 2024. *SnowEx Mores Creek Summit (MCS) Airborne LiDAR Survey, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/NE8CLN3ES5XQ. [Date Accessed].

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

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

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

The data set described here provides digital terrain models (DTM), digital surface models (DSM) snow depth models, and canopy height models (CHM), derived from point cloud data (available as SnowEx Mores Creek Summit (MCS) Airborne LiDAR Survey Raw, Version 1) acquired by airborne lidar scanning. Data were collected as part of a multi-year effort to monitor monthly snow distribution over a 35 km² region of the Mores Creek Headwaters in the Boise Mountains of central Idaho between 2021 and 2025. Data acquisition in 2021 overlapped temporally with the NASA SnowEx 2021 field campaign.

In October 2025, corrupted data files were updated for the following acquisition dates: 8 December 2022 and 9 February 2023.

1.2 File Information

1.2.1 Format

The data are available as Geographic Tagged Image (GeoTIFF, 32-bit) files.

1.2.2 File Contents

Each GeoTIFF file contains embedded georeferenced data representing ground elevation (`DTM`), surface elevation (`DSM`), snow depth (`SD`), or canopy height (`CHM`) in meters.

1.2.3 Naming Convention

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

```
SNEX_MCS_Lidar_YYYYMMDD_[PARAMETER]_V01.0.tif
```

Table 1. File Naming Convention

Variable	Description
`SNEX_MCS_Lidar`	SnowEx Mores Creek Summit Lidar
`YYYYMMDD`	Date of data acquisition formatted as four-digit year, two-digit month, and 2-digit day

[PARAMETER]	Data parameter: • DTM: digital terrain model • DSM: digital surface model • SD: snow depth • CHM: canopy height model
V01.0	Data set version
tif	File extension: GeoTIFF

1.3 Spatial Information

1.3.1 Coverage

Northernmost Latitude: 43.974802

Southernmost Latitude: 43.913645

Easternmost Longitude: 115.64244

Westernmost Longitude: 115.73050

1.3.2 Resolution

The horizontal spatial resolution is 0.5 m.

1.3.3 Geolocation

The following tables provide information for geolocating this data set

Table 2. Geolocation Details

Geographic coordinate system	WGS 84
Projected coordinate system	WGS 84 UTM zone 11N
Longitude of true origin	-117
Latitude of true origin	0
Scale factor at longitude of true origin	0.9996
Datum	WGS_1984
Ellipsoid/spheroid	WGS 84
Units	meters
False easting	500000
False northing	0
EPSG code	32611
PROJ4 string	+proj=utm +zone=11 +datum=WGS84 +units=m +no_defs
Reference	http://epsg.io/32611

1.4 Temporal Information

1.4.1 Coverage

10 March 2021 to 1 May 2025

1.4.2 Resolution

Snow-on data acquisition was acquired over the study site once during the 2020-21 snow season, three times during the 2021-22 snow season, four times during the 2022-23 snow season, six times during the 2023-24 snow season, and four times during the 2024-2025 snow season. In years during which multiple surveys occurred within a snow season, surveys were executed approximately one month apart. Each survey took ~2 hours to complete.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

This data set presents snow depth and canopy height data derived from snow-on and snow-off airborne lidar data for a 35 km² region of Mores Creek Headwaters in the Boise Mountains of central Idaho. Snow-on airborne lidar scans were collected by the Remote Sensing and Geographic Information Systems Center of Expertise (RSGIS CX) at the Cold Regions Research and Engineering Laboratory (CRREL) and the Cryosphere Geophysics and Remote Sensing Group (CryoGARS) at Boise State University between 2021 and 2025.

2.2 Acquisition

Each snow-on lidar data acquisition was conducted using a lidar scanner, Inertial Measurement Unit (IMU), antenna, and flight management system (FMS) attached to a Robinson R66 helicopter using a nose-mounted RaLiPod system. The helicopter was operated by Silverhawk Aviation, based out of Caldwell, Idaho and flown on behalf of Boise State University and CRREL. For each aqcuisition date, a typical mission consisted of the following:

1. 5 minute ground-based initialization period
2. Boresight calibration over built environment, consisting of several passes in different directions over a neighborhood.
3. Main data acquisition over survey domain as weather and fuel allow
4. 5 minute ground-based static-alignment before aircraft shutdown.

Several base stations were used during trajectory processing. The Boise State CryoGARS group operates semi-permanent stations (Pilot Peak and Treeline) consisting of Septentrio PolaRx5 receivers and Trimble Zephyr 3 antennas. These stations are owned and maintained by the Boise State CryoGARS group. Boise State University station owns and maintains a permanent station, which consists of a Trimble NetR9 receiver and Zephyr Geodetic 2 RoHS antenna. From February 2024 to present, a portable base station consisting of a Septentrio Mosaic-X5 GNSS receiver with an NGS Calibrated Survey GNSS antenna was positioned at Silverhawk Aviation (refered to as "temporary base station" in flight data tables). Additional details regarding the base stations, their usage, and their locations can be found in the three provided Technical References (Boise, Idaho Airborne LiDAR Survey at Mores Creek Summit Snow Season Reports 2021-2022, 2022-2023, 2023-2024, and 2024-2025.

2.3 Processing

After data acquisition, the GNSS/IN data and raw laser scanner data were first processed to create point cloud data (LAZ files; available as SnowEx Mores Creek Summit (MCS) Airborne LiDAR Survey Raw, Version 1). The point cloud data was then processed using the ice-road-copters suite to derive four types of raster data: 1) digital surface models (DSM; all surface points), 2) digital terrain models (DTM; all ground points), 3) snow depth models (SD; the difference between the digital terrain model and reference DEM), and (4) canopy height models (CHM; the difference between the digital surface model and reference DEM).

2.3.1 Laser Scanner Data Processing Steps

The following steps were performed using the Riegl RiPROCESS software suite:

1. Post-process the laser scanner data against the SBET to create a point cloud
2. Using planar features in the boresight survey, iteratively adjust sensor orientation parameters (roll, pitch, yaw) to improve the alignment between overlapping data. The orientation solution found during boresight alignment is applied to all AOI records.
3. Minimize offsets between scan data overlap using a least squares solution
4. Export the point cloud (LAZ) from the post processing software into a deliverable file format for all collection records

2.3.2 Creation of raster data using ice-road-copters

The ice-road-copter suite leverages a Point Data Abstraction Library (PDAL) and the NASA's Ames Stereo Pipeline (ASP) and was used to create the final data products listed below. A shapefile of a road that traverses the survey domain and is plowed in winter (such that change between the bare earth and snow-on flights along the road is zero) was used to co-register flights. A summary of point cloud processing via ice-road-copter can be found at on the ice-road-copters github page.

- 0.5 m raster data (.tif files)
  - Digital terrain model (DTM): ground points

- Digital surface model (DSM): surface points
- Canopy height model (CHM): found by subtracting reference map from DSM
- Snow depth (SD): found by subtracting reference map from DTM

2.4 Quality, Errors, and Limitations

Outlying data points were not removed from the snow depth data. Therefore, snow depth maps may have values less than 0 or greater than 3 meters (<1% of all raster values). In some instances, poor weather prevented data collection over the entire study domain.

2.5 Instrumentation

Snow-off lidar data was acquired by Quantum Spatial, which was contracted by Boise State University to collect LiDAR data at Mores Creek as part of NASA's SnowEx 2020 field campaign. These snow-free data were used to produce a 0.5 m resolution bare earth reference DEM, previously published within SnowEx20-21 QSI Lidar DEM 0.5m UTM Grid, Version 1 as `SNEX20_QSI_DEM_0.5M_USIDMC_20210917_20210917.tif` Additional details about the acquisition, processing, and quality of the lidar data used to create the reference DEM can be found in the SnowEx20-21 QSI Lidar DEM 0.5m UTM Grid, Version 1 User Guide and within a detailed report assembled by Quantum Spatial.

Data collected during the 2021-2022 snow season was acquired using a Reigl VQ580 laser scanner and an iXblue ATLANS-C IMU. Data collected from the 2022-2023 season onward was acquired using a REIGL VQ580ii laser scanner and an Applanix AP60 Inertial Measurement Unit. Additional instrument details for each snow season can be found in the four provided References (Boise, Idaho Airborne LiDAR Survey at Mores Creek Summit Snow Season Reports 2021-2022, 2022-2023, 2023-2024, and 2024-2025.

3 VERSION HISTORY

Table 3. Version History Summary

Version	Date Implemented	Impacted Temporal Coverage	Description of Changes
v01.0	October 2024	10 March 2021 to 18 April 2024	Initial release
V01.1	October 2025	12 January 2021 to 13 May 2025	Addition of new data for the 2024-2025 season
		8 December 2022 to 9 February 2023	Replacement of corrupted data files

4 RELATED DATA SETS

SnowEx at NSIDC | Data Sets

SnowEx Mores Creek Summit (MCS) Airborne LiDAR Survey Raw, Version 1

SnowEx20-21 QSI Lidar DEM 0.5m UTM Grid, Version 1

5 RELATED WEBSITES

SnowEx at NSIDC | Overview

Snow Ex at NASA

6 DOCUMENT INFORMATION

6.1 Publication Date

October 2024

6.2 Date Last Updated

October 2025