SnowEx23 Mar23 IOP Community Snow Depth Measurements, Version 1

USER GUIDE

How to Cite These Data

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

Stuefer, S., May, L., Bailey, J., Vas, D., Mason, M., Hale, K., Marshall, H.P., Vuyovich, C., Elder, K., and the SnowEx Alaska March 2023 Team. 2024. *SnowEx23 Mar23 IOP Community Snow Depth Measurements, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/6QD3UJVABY6D. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SNEX23_MAR23_SD

TABLE OF CONTENTS

1.1 Parameters

The data set contains boreal forest and tundra snow depth measurements in Northern Alaska, USA; data were collected during the March 2023 intensive observation period (IOP) as part of the NASA SnowEx 2023 field campaign. The purpose of the ground-based snow depths is to provide validation and calibration data for concurrent SnowEx 2023 airborne lidar and Snow Water Equivalent Synthetic Aperture Radar and Radiometer measurements. Snow depth measurements collected during the March 2022 planning trip that took place in preparation for the SnowEx Alaska field campaigns are available as SnowEx23 Mar22 IOP Snow Depth Measurements, Version 1.

1.2 File Information

1.2.1 Format

Data is provided in a single comma-separated values (.csv) file.

1.2.2 File Contents

The data file contains 16 columns, described in Table 1.

Table 1. File Description

Column Header	Description
State	State in the United States
County	Borough in the state of Alaska
Study Area	Study area
Plot ID	Plot ID
ID	Measurement ID (XXXXXXX, PXX, NXX, or WXX, depending on equipment type)
Date	Date of measurements
Time	Local time, Alaska Standard Time
Latitude	Latitude (decimal degrees)
Longitude	Longitude (decimal degrees)
Northing	Projected y-coordinate in UTM N6, WGS84 (meters)
Easting	Projected x-coordinate in UTM N6, WGS84 (meters)
Elevation	Plot elevation (m)
Depth	Snow depth (cm)
Equipment ID	Datalogger serial number
Instrument	MagnaProbe=MP, pit ruler=PR, depth probe with Mesa2=M2, depth probe without Mesa2=P

Column Header	Description
Version	Version number

1.2.3 Naming Convention

The data file is named `SNEX23_MAR23_SD_AK_20230307_20230316_v01.0.csv`, where `SNEX23` refers to the SnowEx 2023 field campaign, `MAR23` refers to March 2023, `SD` refers to snow depth, `AK` refers to Alaska, `20230307_20230316` represents the 07 March 2023 to 16 March 2023 data collection period, and `v01.0` represents Version 1.

1.3 Spatial Information

1.3.1 Coverage

Northernmost latitude: 70.0902954° N

Southernmost latitude: 64.6817507° N

Easternmost longitude: 147.2396956° W

Westernmost longitude: 149.9726275° W

1.3.2 Resolution

Point measurements

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 6 North
Longitude of true origin	-147
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	32606

PROJ4 string	+proj=utm +zone=6 +datum=WGS84 +units=m +no_defs
Reference	https://epsg.io/32606

1.4 Temporal Information

1.4.1 Coverage

07 March 2023 to 16 March 2023

1.4.2 Resolution

Data points were collected one time.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Snow depths were measured on March 7–16, 2023 as part of the NASA SnowEx 2023 March 2023 Intensive Observation Period (IOP). Ground-based snow depth measurements were taken along transects and in the vicinity of 170 snow pits distributed within five study areas across Northern Alaska. Three study areas represented boreal forest snow near Fairbanks, AK: Farmers Loop Creamers Field (FLCF), Caribou Poker Creeks Research Watershed (CPCRW), and Bonanza Creek Experimental Forest (BCEF). Two study areas represented Arctic tundra snow: Arctic Coastal Plain (ACP) and Upper Kuparuk Toolik (UKT).

Detailed descriptions of study areas, snow plots, classifications, sampling design, and sampling protocols during March 2023 IOP are available in the NASA SnowEx 2023 experiment plan (Vuyovich et al., 2023).

Every site visited within the study area was assigned a Plot ID. Plot IDs were classified using one or two letters followed by a three-digit site number series (ex. EN900 or I800). In boreal forest sites the two letters reference the vegetation class and snow class. For the tundra sites the letter references the tundra snow class. Transects were identified with the code TRAN, followed by a one-digit number. The letter codes are described in the table below.

Table 3. Vegetation and Snow Class Codes

Letter Code	Description
Boreal Forest Plots	
D	Deciduous Forest

E	Evergreen Forest
W	Wetlands
S	Shrub scrub
C	Cultivated crop
B	Below average snow class
N	Neutral or average snow class
A	Above average snow class
TRAN	Transect
Arctic Tundra Plots	
N	Neutral or average (windward)
A	Above neutral (leeward slopes)
D	Snow drift
I	Ice cover (lake / river)

2.2 Acquisition

Snow depth data were measured with manual snow depth probes (foldable ruler, depth probe, and avalanche probe) or a self-recording snow depth measurement device (magnaprobe). All manual snow depth measurements and notes on magnaprobe measurements were recorded in the field books.

The magnaprobe is an automated snow depth probe capable of simultaneously measuring depth and position (Sturm and Holmgren, 2018). It comprises a ski pole-like rod housing a magnetostrictive device, along with a basket and magnet assembly slide. Upon insertion of the rod into the snow base, the basket floats atop the snow. Upon pressing a button, the distance between the rod tip and basket is measured while acquiring position data. The calibration factor for the probe is contained in the logger. The probe calibration is confirmed in the field by taking a zero reading and then sliding the basket to the highest point to confirm the calibration factor. The main components of magnaprobe are Campbell Scientific CR800 series logger, MTS Temposonics G-Series probe, and Garmin GPS16X-HVS receiver.

The geographical position of manual snow depth data point was measured with either 1) compass and tape or 2) Mesa2 mapping-grade GPS tablets (Juniper Systems Mesa2 ruggedized tablet). The tape was used to measure distance from the south-east corner of each plot in a pre-defined direction. The geographical position of the south-east corner was measured with navigation grade GPS at each study plot. The distances and directions of each snow depth data point were written in the field books, while Mesa2 coordinates were saved on the tablets.

The detailed description of snow depth data acquisition methods, sampling patterns, instruments, and accuracy is provided in Stuefer et al., (2024).

2.3 Processing

Snow depth data was processed in one of four ways, depending on the method of data acquisition:

2.3.1 Magnaprobe Data

1. Download information recorded on the CR800 and check data for completion
2. Calculate latitude and longitude, convert to UTM zone 6N, check calibration factor
3. Eliminate erroneous measurements, check for outliers, check notes taken by observers in the field and correct snow depth greater than magnaprobe measurement range (1.2 or 1.3 m depending on the magnaprobe unit)
4. Plot data in ArcMap or similar software to compare with snow pit locations
5. Export data to a single .csv file

2.3.2 Pit Ruler Data

1. Extract pit depths and locations from pit book sheets
2. Calculate latitude and longitude in decimal degrees
3. Export data to a single .csv file

2.3.3 Snow Depth Data with Mesa2

1. Extract snow depths and horizontal distances from snow depth book sheets
2. Align the snow depth points with Mesa2 positioning measurements and merge these two files
3. Calculate latitude and longitude in UTM (6N) and add northing and easting to the data file
4. Plot data and check for positioning in respect to snow pit data set
5. Export data to a single .csv file

2.3.4 Snow Depth Data without Mesa2

1. Extract snow depths, directions, and distances from snow depth book sheets
2. Calculate positioning based on GPS coordinates of the south-east corner and distance from that corner in specified direction
3. Calculate latitude and longitude in decimal degrees and UTM 6N
4. Plot data and check for positioning in respect to snow pit data set
5. Export data to a single .csv file

Once all data were exported to the .csv file, the dataset was sorted based on study area and plot ID.

2.4 Quality, Errors, and Limitations

2.4.1 Location Errors

GPS systems of various accuracies were used to geolocate the measurements. The accuracy of the handheld GPS units used to mark the location of the pit ruler measurement varies between 3-15 m depending on canopy conditions. The accuracy of the magnaprobe GPS is approximately 3 m in open areas and <15 m in forested areas.

2.4.2 Depth Errors

On average, snow depth error varied from 1 to 10 cm depending on vegetation, instruments, snow properties, and measurement techniques (Stuefer et al., 2024). Over-probing occurred due to the insertion of the probe into vegetation/organic layers or measuring air void in snowpack suspended by vegetation. Under-probing occurred due to vegetation or ice layers within the snowpack. Snow surface compaction or cratering caused by the magnaprobe basket was an additional source of error prominent to new snow.

3 ACKNOWLEDGEMENTS

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4 VERSION HISTORY

Table 4. Version History Summary

Version	Date Implemented	Impacted Temporal Coverage	Description of Changes
v01.0	July 2024	07 March 2023 to 16 March 2023	Initial release
v01.0	November 2024	07 March 2023 to 16 March 2023	User guide text updated; data file replaced to correct a formatting error.

5 RELATED DATA SETS

SnowEx23 Mar22 IOP Snow Depth Measurements, Version 1

SnowEx23 Airborne Lidar-Derived 0.5M Snow Depth and Canopy Height, Version 1

SnowEx23 Snow Water Equivalent, Version 1

6 RELATED WEBSITES

NASA SnowEx

NSIDC SnowEx | Overview

7 REFERENCES

Stuefer, S., Hale, K., May, L., Mason, M., Vuyovich, C., Marshall, H. P., Vas, D., & Elder, K. (2024). Ground-based snow depth data from NASA SnowEx Alaska campaign, March 2023, in preparation.

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8 DOCUMENT INFORMATION

8.1 Publication Date

July 2024

8.2 Date Last Updated

November 2024