SnowEx23 Mar23 IOP 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 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].

National Snow and Ice Data Center

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1.1 Parameters

The data set contains snow depth measurements from five study sites in Alaska, USA; data were collected during the March 2023 intensive observation period (IOP) as part of the NASA SnowEx 2023 field campaign. The study sites include three boreal forest sites in the Fairbanks region of central Alaska (the Bonanza Creek Experimental Forest, Caribou Poker Creek watershed, and Farmer's Loop/Creamer's Field) and two coastal tundra sites in the North Slope region (Arctic coastal plain and Upper Kuparuk Toolik). Snow depth measurements collected from the study sampling sites during the previous field season 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

Column Header	Description
Instrument	MagnaProbe=MP, pit ruler=PR, depth probe with Mesa2=M2, depth probe without Mesa2=P
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 Observing Period (IOP). Snow depth ground-based measurements were taken along transects and in the vicinity of 170 snow pits distributed within five study areas. Three study areas were in the boreal forest around Fairbanks, AK: Farmers Loop Creamers Field (FLCF), Caribou Poker Creeks Research Watershed (CPCRW), and Bonanza Creek Experimental Forest (BCEF). Two study areas were in Arctic tundra: 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 Sites	

D	Deciduous Forest
E	Evergreen Forest
W	Wetlands
B	Below average snow class
N	Neutral or average snow class
TRAN	Transect
Tundra Site	
I	Ice cover (lake / river)
N	Neutral (windward)

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 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. 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

Depth errors are known to be associated with magnaprobe probing. Over-probing can occur due to the insertion of the probe into thawed soil or vegetation/organic layers. Under-probing can occur due to vegetation or ice layers within the snowpack. Snow surface compaction or cratering, caused by the magnaprobe basket, can be an additional source of error; this is more prominent after new snow. The error due to over-probing is close to zero for frozen soils and 5-10 cm in soft substrates. The error due to cratering is estimated to be around 1 cm.

3   ACKNOWLEDGEMENTS

The snow depth data were collected by the SnowEx Alaska March 2023 team: Glen Liston, Jewell Lund, Julien Meloche, Jon Maakestad, Ryan Webb, HP Marshall, Juha Lemmetyinen, Juho Vehvilainen, Tate Meehan, Mike Durand, Zach Keskinen (Hoppinen), Zoe Courville, Kate Hale, Sveta Stuefer, Kelly Elder, Lora May, Joel Bailey, Art Gelvin, Kate Liddle-Broberg, Hannah Wittmann, Wyatt Reis, Angus Goodbody, Anna Valentine, Kaitlin Meyer, Carrie Vuyovich, Ibrahim Alabi, Naheem Adebisi, Dan McGrath, Hans Lievens, Devon Dunmire, Isis Brangers, Dragos Vas, Brad Baxter, Megan Mason, Randall Bonnell, Karina Zikan, Zach Fair, Andrew Hedrick, Jesslyn Di Fiori, Alan Bourgeois, and Mike Sutherland. IOP operations were supported by Toolik Field Station on the North Slope and by SnowEx operation team (Sarah Dutton, Leanne Kendig, Jeb Timm, and Jim Sackett) led by Dan Hodkinson.

Special thanks to Juho Vehvilainen for downloading and organizing magnaprobe data and field notes. This helped tremendously with data quality control.

This data publication is supported by NASA Terrestrial Hydrology Program 80NSSC23K1419.

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

5   RELATED DATA SETS

SnowEx23 Mar22 IOP Snow Depth Measurements, Version 1
SnowEx23 Airborne Lidar-Derived 0.25M 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). Snow depth data from NASA SnowEx March 2023 campaign in Alaska. Arctic Science, in Preparation.

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8 DOCUMENT INFORMATION

8.1 Publication Date

July 2024

8.2 Date Last Updated

July 2024