SnowEx23 Snow Water Equivalent, Version 1

USER GUIDE

How to Cite These Data

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

Stuefer, S., M. Lora, M. Mason, H.P., Marshall, D. Vas, K. Elder, and SnowEx Alaska March 2023 Team. 2024. *SnowEx23 Snow Water Equivalent, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/FRAMQ2JFF6J9. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SNEX23_SWE

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

This data set presents snow depth, snow water equivalent (SWE), and bulk snow density data collected during the NASA SnowEx 2023 field campaign between March 13-16 2023. Samples were collected using an Adirondack snow sampler from two study sites: Upper Kuparuk and Toolik (UKT), an arctic tundra environment in Northern Alaska, and Farmers Loop Creamers Field (FLCF), a boreal forest near Fairbanks, Alaska.

1.2 File Information

1.2.1 Format

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

1.2.2 File Contents

The file starts with a header indicating the type of data, the period of record, measurement frequency, and a brief data description. Also included is an explanation of column headers, a description of data flags, funding sources, acknowledgements, and contact information. This is followed by 19 columns of data. Column names are described in Table 1.

Table 1. Data Parameters

Column Title	Description	Unit/Format
State	State in the United States	
County	Borough in the state of Alaska	
Site ID	Identification of the snow survey site	
Latitude	Latitude in decimal degrees	
Longitude	Longitude in decimal degrees	
Elevation	Site elevation	m
Date	Date of measurements	
Depth1	Snow depth of sample 1	cm
Depth2	Snow depth of sample 2	cm
Depth3	Snow depth of sample 3	cm
Mass1	Mass of snow sample 1	g
Mass2	Mass of snow sample 2	g
Mass3	Mass of snow sample 3	g

Column Title	Description	Unit/Format
Density1	Snow density of sample 1	kg/m^3
Density2	Snow density of sample 2	kg/m^3
Density3	Snow density of sample 3	kg/m^3
SWE1	Snow water equivalent of sample 1	mm
SWE2	Snow water equivalent of sample 2	mm
SWE3	Snow water equivalent of sample 3	mm

Two flags values are used to indicate missing data; -9999 values indicate data were not collected and -7777 values indicate individual measurements are missing geographical data.

1.2.3 Naming Convention

This data set consists of a single file:

`SNEX23_SWE_Mar23IOP_AK_20230313_20230316_v01.0.csv`

1.3 Spatial Information

1.3.1 Coverage

Northernmost Latitude: 68.6150 N
Southernmost Latitude: 64.8677º N
Easternmost Longitude: 147.6745° W
Westernmost Longitude: 149.4940 ° W

1.3.2 Resolution

Point measurements

1.3.3 Geolocation

The following table provides information for geolocating this data set.

Table 2. Geolocation Details

Geographic coordinate system	WGS 84
EPSG code	4326
PROJ4 string	+proj=longlat +datum=WGS84 +no_defs +type=crs
Reference	https://epsg.io/4326

1.4 Temporal Information

1.4.1 Coverage

13 March 2023 to 16 March 2023

1.4.2 Resolution

Point measurements

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Snow water equivalent (SWE), snow depth, and bulk snow density data were collected during NASA SnowEx 2023 field campaign. SWE samples were collected in the Arctic tundra at the Upper Kuparuk and Toolik (UKT) study area and in a boreal forest at the Farmers Loop Creamers Field (FLCF) study area (Figure 1). This data set complements the NASA SnowEx 2023 snow pit measurements.

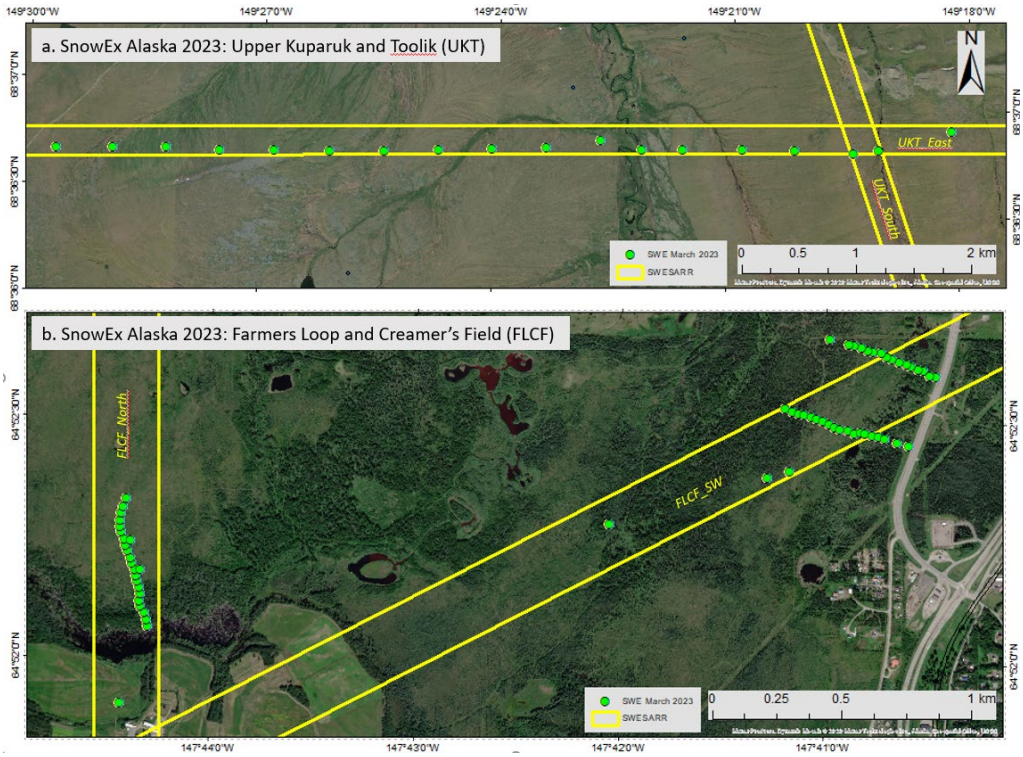

Figure 1. Snapshot of the UKT (a) and FLCF (b) study areas showing SnowEx23 *in situ* SWE measurement sample locations and corresponding SWESARR swaths.

2.2 Acquisition

SWE was sampled using a fiberglass tube ("Adirondack") with an inside area of 35.7 cm^2, equipped with metal teeth on the lower end to cut through dense layers of snow (Stuefer et al., 2020). To obtain a complete snow sample, the Adirondack sampler was pushed vertically through the snow while simultaneously being rotated, until organic soil or vegetation was encountered. Snow depth was then recorded using the gradation marks on the sampler. The sampler was then driven further into the organic layer and then tipped sideways to capture a vegetation plug. This ensured that the complete snow column was sampled. The vegetation plug was removed and measured. The snow sample was then removed from the tube and weighed to determine the mass of snow sample.

Three snow samples were taken at each designated sampling location, which were distributed along transects within UKT and FLCF study areas. SWE samples in the UKT study area were distributed along a 10 km line within the UKT_East SWESARR swath with 400–500 km spacing (Figure 1a). SWE samples in the FLCF study area were collected along a 300–500 m line in the FLCF_North SWESARR swath and along two 500 m lines within the FLCF_SW SWESARR swath with 25–50 m spacing (Figure 1b).

2.3 Processing

Bulk snow density and SWE were calculated using the following equations (Stuefer et al., 2020):

$$\rho_s = m/(A \times h_s) \quad (1)$$

$$SWE = 10 \times m/(A \times \rho_w) \quad (2)$$

where *SWE* is snow water equivalent (mm), ρ_s is bulk snow density (g/cm^3), ρ_w is water density (g/cm^3), *m* is mass of snow sample (g), h_s is snow depth (cm), and *A* is cross-sectional area of the inside of a cutter (cm^2); *10* is the conversion factor between centimeters and millimeters.

2.4 Quality, Errors, and Limitations

This dataset has undergone quality assessment and quality control. The potential sources of error are related either to the snow depth measurement or snow sample collection, as described below.

2.4.1 Snow Depth

Snow depth is measured with accuracy to 1–2 cm using snow tube gradation scale.

2.4.2 Snow Density and SWE

Snow might fall out from the snow sampler resulting in underestimation of bulk snow density and SWE. The magnitude of this underestimation error depends on observer, instrument, and snow conditions, and can be estimated by comparing the bulk snow densities reported here with detailed snow pit density profile measurements. Similarly, SWE values reported here can be compared with SWE sampler measurements collected at the snow pit walls to estimate magnitude of the error.

2.5 Examples of SWE and Snow Density Measurements

The SWE data presented here capture differences between tundra and boreal forest snow types. Large variability in both SWE and snow depth was observed in tundra locations (Figure 2a and Figure 2b). The SWE range in tundra snow (24–257 mm) is greater than the SWE range in boreal forest locations (61–176 mm) by a factor of two (Figure 2a). On average, there is more snow accumulated in boreal forest (median SWE is 121 mm and median snow depth is 70 cm) than in Arctic tundra locations (median SWE is 84 mm and median snow depth is 45 cm). Tundra snow is more dense than boreal forest snow (Figure 2c).

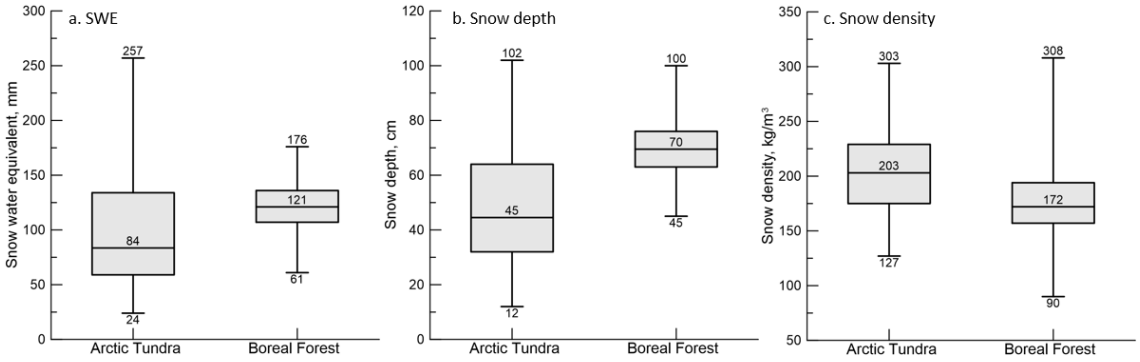

Figure 2. Summary of SWE (a), snow depth (b), and snow density (c) measurements by tundra and boreal forest snow classes. This dataset contains 66 observations from Arctic tundra collected on March 13, 2023 and 184 observations from boreal forest collected on Ma

3 VERSION HISTORY

Table 3. Version History Summary

Version	Release Date	Description of Changes
V1	June 2024	Initial Release

4 RELATED DATA SETS

SnowEx at NSIDC | Data sets

5 RELATED WEBSITES

SnowEx at NSIDC | Overview

SnowEx at NASA

NASA SnowEx 2023 Experimental Plan

6 REFERENCES

Stuefer, S. L., Kane, D. L., & Dean, K. M. (2020). Snow Water Equivalent Measurements in Remote Arctic Alaska Watersheds. *Water Resources Research*, *56*(4). https://doi.org/10.1029/2019WR025621

Vuyovich, C., Stuefer, S., Durand, M., Marshall, H. P., Osmanoglu, B., Elder, K., Vas, D., Gelvin, A., Larsen, C., Pedersen, S., Hodkinson, D., Deeb, E., Mason, M., & Youcha, E. (2023). *NASA SnowEx 2023 Experiment Plan*. https://snow.nasa.gov/sites/default/files/users/user354/SNEX-Campaigns/2023/NASA_SnowEx_Experiment_Plan_2023_draft_21Nov2022.pdf

7 DOCUMENT INFORMATION

7.1 Publication Date

June 2024

7.2 Date Last Updated

June 2024