SnowEx17 SnowMicroPen (SMP) Raw Penetration Force Profiles, Version 1

USER GUIDE

How to Cite These Data

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

Derksen, C., M. Teich, M. Brady, and J. King. 2017. *SnowEx17 SnowMicroPen (SMP) Raw Penetration Force Profiles, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/ZPOLBRHVWG5V. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SNEX17_SMP

National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

Measurements are raw SnowMicroPen (SMP) profiles, to a maximum depth of 120 cm. In some cases, when snow depth exceeded 120 cm, two profiles were acquired to cover the entire depth.

Summary of SnowEx 2017 SMP measurements at pits and transects.

- Snow Pits
  - 62 SnowEx snow pits with SMP profiles for a total of 571 profiles. Snow depth distribution shown in Figure 1.
  - 61 SMP profiles at SnowEx pits have coincident SnowEx17 Laser Snow Microstructure Specific Surface Area Data (SNEX17_SSA) profiles.
  - SMP profiles at SnowEx pits have casting for microCT analysis.
- Transects
  - 43 transects of SMP measurements acquired along SnowEx transect lines, for a total of 1084 profiles.
  - SMP transect lengths vary from 10 to 300 m in length; measurement spacing varies from 10 cm to 20 m.

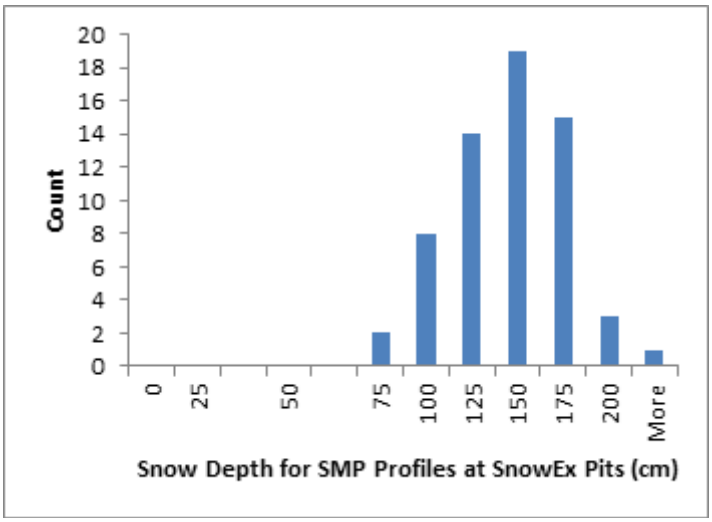

Figure 1. Snow Depth Distribution

1.1 Format

Data files are in Comma Separated Values (.csv) format.

A quicklook plot (.png) of each profile is included.

A single index file with reference information for each of the profiles is available as a technical reference.

Extensible Markup Language (.xml) files with associated metadata are also provided.

1.2 File and Directory Structure

Data are available at: `https://n5eil01u.ecs.nsidc.org/SNOWEX/SNEX17_SMP.001/`

Within this directory, folders are organized by date in YYYY/MM/DD format, for example /2017.02.24/.

1.3 File Naming Convention

Data files are named according to the following conventions and as described in Table 1:

`SnowEx17_SMP_N_PitNNL_YYYYMMDD_XNNNNNNN.xxx`

Table 1. File Naming Convention

Variable	Description
SnowEx17_SMP	Short name for SnowEx17 SnowMicroPen (SMP) Raw Penetration Force Profiles
_N_	Identifies and differentiates between three SMP units used in the field, where: A = SMP Serial Number 2 B = SMP Serial Number 34 C = SMP Serial Number 40
PitNNL	Pit, trench, or transect identifier
YYYY	4-digit year of survey
MM	2-digit month of survey
DD	2-digit day of survey
XNNNNNNN	Instrument-assigned file number
.xxx	Indicates file type: .csv, .xml, or png

Example file name:

`SnowEx17_SMP_A_Pit36N_20170207_A7380059.csv`

1.4 File Size

CSV (.csv) files range from approximately 3 to 5 MB.

XML (.xml) are approximately 4 KB each.

PNG (.png) files range from approximately 37 to 45 KB.

1.5 Volume

CSV files are approximately 8 GB.

XML files are approximately 5 MB.

PNG files are approximately 61 MB.

1.6 Spatial Coverage

Southernmost Latitude 38.98° N
Northernmost Latitude: 39.03° N
Westernmost Longitude: 108.23° W
Easternmost Longitude: 107.85° W

1.6.1 Spatial Resolution

Each individual profile was acquired at a single point, with a vertical resolution of less than 1 mm.

Point measurements along transect from 10 to 300 m in length. Measurement spacing varies from 10 cm to 20 m.

1.7 Temporal Information

These data were collected as part of the SnowEx campaign from 07 February 2017 to 25 February 2017.

1.7.1 Temporal Resolution

Measurements were made at a single point in time and were not repeated.

1.8 Parameter or Variable

1.8.1 Parameter Description

Table 2. Data File Parameter Descriptions

Parameter	Description	Units
Depth	Depth of snow measurement	Millimeters (mm)
Force	Force required to drive a motorized probe into the snow at a constant measurement speed of 20 mm/s	Newtons (N)

1.8.2 Sample Data Record

Below is a sample of data file `SnowEx17_SMP_A_Pit36N_20170207_A7380059.csv`.

# SMP Serial: 2	
# Date: 2017-02-07	
# Time (UTC): 22:40:23	
# Lat: 39.025970459	
# Lon: -108.099624634	
# Total Samples: 266200	
# Depth (mm)	Force (N)
0	0.415683
0.004132	0.051303
0.008264	0.053934
0.012397	0.053934
0.016529	0.05788
0.020661	0.056564
0.024793	0.05788
0.028926	0.05788

Figure 2. Illustrates a quick look plot of the `SnowEx17_SMP_A_Pit36N_20170207_A7380059.csv` profile.

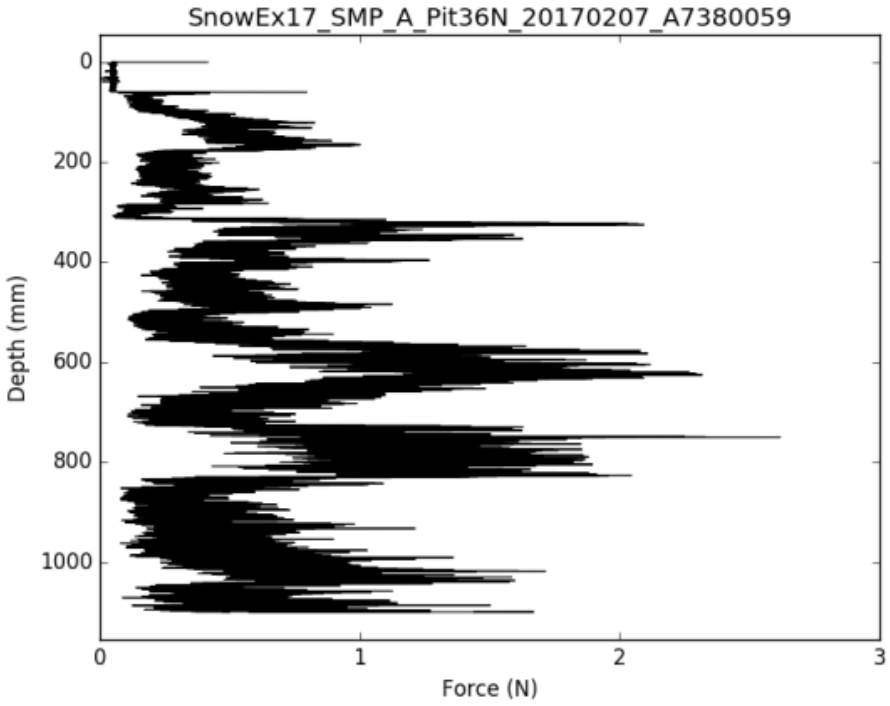

Figure 3. Sample force profile (`SnowEx17_SMP_A_Pit36N_20170207_A7380059.png`)

2 SOFTWARE AND TOOLS

2.1 Software and Tools

CSV files can be read with any text editor or word processing program capable of reading ASCII text files.

XML files can be read with browsers such as Firefox and Internet Explorer.

PNG files can be displayed by a wide selection of image displaying software.

Python code for vertically smoothing the raw SMP profiles, and converting force to snow microstructure parameters is available at https://github.com/m9brady/SMP_to_CSV

2.2 Quality Assessment

SMP profiles were screened to ensure complete profiles were acquired. If the vertical profiles were incomplete (due to instrument malfunction or ice layers/obstructions in the snowpack) the data were not retained. In very limited cases, negative force measurements were obtained for a small proportion of measurements within a profile. These negative values were removed.

3 DATA ACQUISITION AND PROCESSING

3.1 Theory of Measurements

The Snow MicroPen acquires high vertical resolution measurements of the force required to move a sensor downward through the snowpack at a constant measurement speed of 20 mm/s. Details are provided in Schneebeli and Johnson (1998), Johnson and Schneebeli (1999), and Proksch et al. (2015).

3.2 Data Acquisition Methods

Spatial variability in snow microstructure was measured during SnowEx 2017 using the rapid sampling capabilities of the SMP. The SMP acquires high vertical resolution (~250 measurements per mm) profiles of the force measured in Newtons (N) required to drive a motorized probe into the snow at a constant measurement speed of 20 mm/s. Typical force measurements range from 0.01 N for soft snow up to 40 N for very hard snow, to a maximum depth of 1.2 m.

From these force measurements, snow microstructure parameters such as density, layering, snow grain type, and snow grain specific surface area (SSA) can be derived, but only the raw force profiles are provided in this data set. Users will need to apply algorithms for identifying the air/snow and snow/ground interfaces, vertically smoothing the raw data, and converting the force measurements to snow microstructure parameters (see https://github.com/m9brady/SMP_to_CSV).

SMP measurements were made at snow pit locations, and in transects of variable length/spacing through all three weeks of the SnowEx 2017 campaign.

3.3 Derivation Techniques and Algorithms

3.3.1 Processing Steps

- The SMP generates a data file and header file for each profile measurement.
- Relevant fields from the header (date, time, lat/lon etc.) were stripped and inserted to the top of the data file.
- The data file contains two fields: depth and force.
- A single index file is also provided with reference information for each of the profiles.

3.3.2 Errors and Limitations

In very limited cases, negative force measurements were obtained for a small proportion of measurements within a profile. These negative values were removed. Other potential sources of uncertainty include the probe not entering the snowpack orthogonally to the surface (due to imprecise placement of the instrument base) and shifting of the probe during measurement due to snowpack settling.

3.4 Sensor or Instrument Description

The SMP measures the bonding force between snow grains. As described by the manufacturer, the SnowMicroPen is a cone penetrometer used to measure bonding forces between snow grains for snow profiling, stratigraphy, and other applications. The SMP drives a rod with a force sensor at a constant speed of approximately 20 mm/s into snow and samples penetration force every four micrometers (see Schnee- und Lawinenforschung (SLF)). Table 3 contains more details about the instrument.

Table 3. Instrument Specifications (see SLF full specifications: SnowMicroPen)

Parameter	Value	Units
Measurable snow depth	0.27, 0.83, 1.25 (default), 1.72 or 2.2	m
Vertical penetration velocity	20	mm/s
Vertical sampling resolution	4	µm
Vertical layer resolution	.05	mm

4 REFERENCES AND RELATED PUBLICATIONS

Johnson, J.B., Schneebeli, M. 1999. Characterizing the microstructural and micromechanical properties of snow. Cold Regions Science and Technology 30(1-3), 91-100.

Proksch, M., H. Löwe, and M. Schneebeli. 2015. Density, specific surface area, and correlation length of snow measured by high-resolution penetrometry, J. Geophys. Res. Earth Surf., 120:346–362. doi:10.1002/2014JF003266.

Schneebeli, M., Johnson, J.B. 1998. A constant-speed penetrometer for high-resolution snow stratigraphy. Annals of Glaciology 26, 107-111.

4.1 Related Websites

SnowEx at NASA

SnowMicroPen

The SnowMicroPen as a tool to integrate multiple scales in quantitative snow measurements

5 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Publication Date

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6.2 Date Last Updated

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