



SnowEx20 Grand Mesa Autumn 2019 Snow Pits, Version 1

USER GUIDE

How to Cite These Data

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

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SNEX20_A19_SP



National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

This data set contains snow pit measurements obtained as part of the SnowEx 2020 campaign at the Grand Mesa, Colorado, USA site in Autumn 2019. 21 locations were visited for snow pit observations. Some snow pit measurements are incomplete due to shallow or discontinuous snow cover. The main parameters were temperature, snow density, stratigraphy, and grain size. On rare occasions, snow permittivity was measured to derive liquid water content (LWC).

Also available are photos taken of the pit sheets and the site. Table 1 describes the available measured file types in more detail.

1.2 File Information

1.2.1 Format

Snow pit data are provided as Microsoft Excel (.xlsx) and comma-separated value (.csv) files. Snow pit photos are provided as Joint Photographic Experts Group (.jpg) files.

1.2.2 File Contents

For each snow pit the data package includes the pit sheet in .xlsx format, a site detail file in .csv, and photos (.jpg) taken of the pit data sheets and the site, and individual data files in .csv for snow density, LWC, stratigraphy, and temperature.

The available file types and their content descriptions are summarized in Table 1.

Table 1. File types and content

File Type	Content description
Snow pit sheet	File contains all data from the snow pits in .xlsx format
Site photos	Photos taken of pit sheets, snow pit wall (sometimes with an infrared camera), and the site in 4 cardinal directions, directly up towards the sky and sometimes directly down towards the ground
Site Details	Location, site and pit ID, date/time, UTM coordinates, slope, total snow depth, weather and ground conditions, tree canopy density, and comments.
Density	Density (kg/m ³) profiles at 5 cm intervals
LWC	Dielectric constant and calculated LWC profiles
Stratigraphy	Layer thickness, grain size, grain type, manual wetness, and hand hardness

File Type	Content description
Temperature	Temperature (°C) at surface and in 5-10 cm intervals
Environment	A global file for all snow pits at Grand Mesa containing qualitative observations about potentially impactful environmental conditions, such as precipitation, cloud cover, wind, and ground cover.

Note: No QA/QC was performed on non-numerical values in the data files.

1.2.3 Naming Convention

1.2.3.1 Snow Pit Sheet File Naming Convention

Snow pit sheet files are named according to the following convention described in Table 2:

SNEX20_A19_SP_GM_<yyyymmdd>_<pitID>_v<nn>.xlsx

Table 2. Snow Pit Sheet File Naming Convention

Variable	Description
SNEX20_A19_SP	Short for SnowEx20 Grand Mesa Autumn 2019 Snow Pit data
GM	Referring to the snow pit sheet at Grand Mesa, Colorado
<yyyymmdd>	Date of data collection, in year-month-day format
<pitID>	Snow pit ID. IDs vary in length and can include underscores
v<nn>	Indicates version number of the data set
.ext	File extension: .xlsx = Microsoft Excel file

An example for a snow pit sheet file for snow pit (5C26) is shown below:

SNEX20_A19_SP_GM_20191104_5C26_v01.xlsx

1.2.3.2 Individual Parameter File Naming Convention

Individual parameter files are named according to the following convention described in Table 3:

SNEX20_A19_SP_GM_<yyyymmdd>_<pitID>_<parameter>_v<nn>.csv

Table 3. Individual Parameter File Naming Convention

Variable	Description
SNEX20_A19_SP_GM	Short for SnowEx20 Grand Mesa Autumn 2019 Snow Pit data
<yyyymmdd>	Date of data collection, in year-month-day format
<pitID>	Snow pit ID. IDs vary in length and can include underscores
<parameter>	Possible options are: density; LWC; stratigraphy; and temperature.

Variable	Description
v<nn>	Indicates version number of the data set
.csv	File extension: csv = comma separated value file

A complete list of parameter data files for an exemplary snow pit (9C16) are shown below:

- SNEX20_A19_SP_GM_20191104_5C26_density_v01.csv
- SNEX20_A19_SP_GM_20191104_5C26_LWC_v01.csv
- SNEX20_A19_SP_GM_20191104_5C26_siteDetails_v01.csv
- SNEX20_A19_SP_GM_20191104_5C26_stratigraphy_v01.csv
- SNEX20_A19_SP_GM_20191104_5C26_temperature_v01.csv

1.2.3.3 Site Photograph Naming Convention

Site photographs are named according to the following convention described in Table 4:

SNEX20_A19_SP_GM_<yyyymmdd>_<pitID>_<content>_v<nn>.jpg

Table 4. Site Photograph File Naming Convention

Variable	Description
SNEX20_A19_SP_GM	Short for SnowEx20 Grand Mesa Autumn 2019 Snow Pit data
<yyyymmdd>	Date of data collection, in year-month-day format
<pitID>	Snow pit ID. IDs vary in length and can include underscores
<content>	Contents of the image: book1 / book2 = image of the field book north = picture taken looking north of the snow pit south = picture taken looking south of the snow pit east = picture taken looking east of the snow pit west = picture taken looking west of the snow pit pit = picture of the snow pit wall pitIR = infrared picture of the snow pit wall up = picture of the sky above the snow pit
v<nn>	Indicates version number of the data set
.jpg	File extension: jpg = Joint Photographic Experts Group file

A complete list of site photograph files for an exemplary snow pit (5C26) are shown below:

- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_book1_v01.jpg
- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_book2_v01.jpg
- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_north_v01.jpg
- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_east_v01.jpg
- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_south_v01.jpg
- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_west_v01.jpg

- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_pit_v01.jpg
- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_pitIR_v01.jpg
- SNEX20_A19_SP_SnowPits_GM_20191104_5C26_up_v01.jpg

1.3 Spatial Information

1.3.1 Coverage

Northernmost Latitude: 39.046° N

Southernmost Latitude: 39.008° N

Easternmost Longitude: 108.151° W

Westernmost Longitude: 108.201° W

1.3.2 Resolution

Point measurements

1.3.3 Geolocation

The following table provides information for geolocating this data set.

Table 5. Geolocation Details

Geographic coordinate system	WGS 84
Projected coordinate system	WGS 84 / UTM Zone 12 North
Longitude of true origin	-111
Latitude of true origin	0
Scale factor at longitude of true origin	0.9996
Datum	WGS 84
Ellipsoid/spheroid	WGS 84
Units	meters
False easting	500000
False northing	0
EPSG code	32612
PROJ4 string	+proj=utm +zone=12 +datum=WGS84 +units=m +no_Defs
Reference	https://epsg.io/32612

1.4 Temporal Information

1.4.1 Coverage

04 November 2019 – 06 November 2019

1.4.2 Resolution

N/A

2 DATA ACQUISITION AND PROCESSING

2.1 Background

This data set contains snow pit measurements obtained as part of the SnowEx 2020 campaign at the Grand Mesa, Colorado, USA site in Autumn 2019. Measurements were made in the shallow, discontinuous snow cover. Data were recorded for 21 snow pits at 19 locations (2 locations were revisited).

2.2 Acquisition

Measurements were made using a standard pit kit, which included a 250 cm³ wedge density cutter, digital scale, graduated macroscope, 2 mm grid cards for visual inspection of grain size, and digital thermometer. The dielectric constant was measured using an A2 Photonic WISe LWC sensor. LWC was calculated from the measured dielectric constant and derived snow permittivity. See Table 6 for more details on the instrumentation used.

Sensor serial numbers were recorded in the site details file.

Measurements were hand-written in field notebooks and later converted into electronic form.

2.3 Processing

Dielectric constant was measured using the [A2 Photonic WISe LWC sensor](#). The permittivity is calculated by multiplying the dielectric constant with the permittivity of vacuum. The LWC was calculated using the below formula taken from the WISe LWC user manual.

$$\varepsilon = 1 + 1.202 * (D - W_v) + 0.983 * (D - W_v)^2 + 21.3 * W_v$$

Where ε is the permittivity of snow; D is the snow density (g/cm³), averaged over all measurements taken at that layer; and W_v is the volumetric liquid water content. In practice, the following iteration was used to compute W_v :

Start with $W_v = 0$ and repeat 5 times $D_s = D - W_v$

$$W_v = \frac{\epsilon - 1 - 1.202 * D_s - 0.983 * D_s^2}{21.3}$$

For each layer, an average density was calculated from the measurements and used with each permittivity measured within that layer to compute LWC.

2.4 Quality, Errors, and Limitations

GPS systems of various accuracies were used to geolocate the measurements. It may be assumed that handheld GPS units were ~3 to 15 m in accuracy depending on canopy conditions.

Since the snow cover was shallow the snow pit measurements were impacted by vegetation or air gaps caused by vegetation resulting in incomplete samples. Measurements of permittivity and derived LWC may therefore be uncertain.

2.5 Instrumentation

Table 6 lists all instruments used to record measurements in this snow pit data set.

Table 6. Instrument Specifications

Instrument	Brand	Measurement	Specifications
Global Positioning System (GPS) field unit	Garmin Rino 755T	Latitude, longitude, elevation	horizontal error +/- 3 m in open, +/- 10 m in trees
Digital Thermometer	Copper-Atkins model DFP450W	snow temperature profiles	accuracy +/-1° C, resolution 0.1° C, 121 mm stem
Snow Liquid Water Content (LWC) Sensor	A2 Photonics WISe	LWC profiles	+/-1%
Digital Scale	AD-3000	snow sample mass for density profiles	3100 g capacity, 1 g resolution, 1 g repeatability
Snow Density sampler, 250 cc capacity	Snowmetrics RIP 2 – 250 cc capacity	Snow density profiles	+/- <1% volume, 5 x 10 x 10 cm wedge-shaped cutter
Pocket microscope	RF Insterscience Macroscope 25A	snow crystal type identification and size quantification	2 magnification, 8 mm field of view, graduated reticule with 0.1 mm resolution

Instrument	Brand	Measurement	Specifications
Folding ruler	N/A	for measure snow height (HS), stratigraphic boundary heights, layer thickness,	2 m fiberglass folding rule, mm graduations

3 SOFTWARE AND TOOLS

CSV files can be accessed using software that reads ASCII text.

4 VERSION HISTORY

Table 7. Version History Summary

Version	Release Date	Description of Changes
v01	09 October 2021	Initial release

5 RELATED DATA SETS

[SnowEx at NSIDC | Data Sets](#)

[SnowEx20 Grand Mesa Autumn 2019 Snow Water Equivalent](#)

[SnowEx20 Grand Mesa Autumn 2019 Gravimetric Soil Moisture](#)

[SnowEx20 Grand Mesa Autumn 2019 Snow Depth](#)

6 RELATED WEBSITES

[SnowEx at NSIDC | Overview](#)

[NASA SnowEx](#)

7 CONTACTS AND ACKNOWLEDGMENTS

Ludovic Brucker

NASA GSFC / USRA

Carrie Vuyovich

NASA GSFC

Kelly Elder

U.S. Forest Service

Hans-Peter Marshall

Boise State University

Christopher Hiemstra

ERDC Cold Regions Research and Engineering Laboratory

8 DOCUMENT INFORMATION

8.1 Publication Date

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8.2 Date Last Updated

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