



SnowEx20 Grand Mesa Autumn 2019 Snow Water Equivalent, Version 1

USER GUIDE

How to Cite These Data

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

Brucker, L., J. Zhu, H. Shen and C. Vuyovich. 2021. *SnowEx20 Grand Mesa Autumn 2019 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/10.5067/4QTIRJQIF8E2>. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SNEX20_A19_SWE



National Snow and Ice Data Center

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1 DATA DESCRIPTION

The main parameters in this data set are snow depth, snow density and snow water equivalent (SWE) obtained from samples collected with SWE samplers (also referred to as SWE tubes).

1.1 File Information

1.1.1 Format

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

1.1.2 File Contents

The file starts with a header indicating the location Grand Mesa, Colorado as study site and the UTM Zone 12. This is followed by 11 columns of data. Column names are described in Table 1. Note: A, B, and C refer to three different samples/measurements obtained in the same location.

Table 1. Data Parameters

Column Title	Description	Unit/Format
Date	Date of data acquisition in Coordinated Universal Time	YYYYMMDD
Time	Time of day of data acquisition in Coordinated Universal Time [HHMM]	HHMM
Site (Oct. naming convention)	Alternative site names using the October 2019 naming convention	N/A
Site (Jan. naming convention)	Site name using the January 2020 naming convention described in more detail in Appendix A – SnowEx Grand Mesa IOP Snow PIT Naming Convention Description	N/A
Easting	UTM Easting	m
Northing	UTM Northing	m
Snow Depth A	Snow depth measurement (first sample)	cm
SWE A	Snow water equivalent (first sample)	mm
Density A	Snow density (first sample)	kg/m ³
Snow Depth B	Snow depth measurement (second sample)	cm
SWE B	Snow water equivalent (second sample)	mm
Density B	Snow density (second sample)	kg/m ³
Snow Depth C	Snow depth measurement (third sample)	cm
SWE C	Snow water equivalent (third sample)	mm

Column Title	Description	Unit/Format
Density C	Snow density (third sample)	kg/m ³
Snow Depth Mean	Mean snow depth from all samples/measurements (A, B and C)	cm
SWE Mean	Mean snow water equivalent from all samples/measurements (A, B and C)	cm
Density Mean	Mean snow density from all samples/measurements (A, B and C)	kg/m ³
Surveyor	Surveyor taking the measurement	N/A

1.1.3 Naming Convention

This data set consists of a single file, named: SNEX20_A19_SWE_v01.csv

The file naming convention is described in Table 2.

Table 2. File Naming Convention

Variable	Description
SNEX20_A19_SWE_	SnowEx 2020 Grand Mesa Autumn 2019 Snow Water Equivalent
v01	Data set version
.csv	File extension

1.2 Spatial Information

1.2.1 Coverage

Northernmost Latitude: 39.045793 ° N

Southernmost Latitude: 39.008324 ° N

Easternmost Longitude: 108.133243 ° W

Westernmost Longitude: 108.210066 ° W

1.2.2 Resolution

Point measurements

1.2.3 Geolocation

The following table provides information for geolocating this data set.

Table 3. 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 1984
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

1.3 Temporal Information

1.3.1 Coverage

Start Date: 03 November 2019

End Date: 06 November 2019

1.3.2 Resolution

Point measurements

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Snow depth, snow density and SWE were measured in autumn 2019 (03-06 November) as part of the NASA SnowEx 2020 campaign in Grand Mesa CO. Measurements were taken in the vicinity of snow pit locations, and they were always taken at least twice at 1-2 m apart. This data set includes 221 measurement locations. The measurement protocol is described in the [SnowEx 2020 Experiment Plan](#).

2.2 Acquisition

SWE measurements of the autumn shallow snow were obtained using SWE samplers (also referred to as SWE tubes). Measurements were recorded in hand-written field notebooks and later converted into electronic form.

2.3 Processing

Snow density was calculated using the following equation:

$$\text{Snow density [kg/m}^3\text{]} = \text{SWE [mm]} / (\text{snow depth [cm]} \times 10) \times \rho_{\text{water}} (1000 \text{ kg/m}^3)$$

2.4 Quality, Errors, and Limitations

The depth ruler was graduated every 2 mm and the SWE scale was graduated every 1 mm. GPS systems of various accuracies were used to geolocate the measurements. These handheld GPS devices are assumed to have errors of ~3-15 m in accuracy depending on canopy conditions.

2.5 Instrumentation

Ground-based observation, [SWE sampler](#).

3 SOFTWARE AND TOOLS

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

4 VERSION HISTORY

Table 4 Version History Summary

Version	Release Date	Description of Changes
V1	03 June 2021	Initial Release

5 RELATED DATA SETS

[SnowEx at NSIDC| Data Sets](#)

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

[SnowEx20 Grand Mesa Autumn 2019 Snow Depth](#) (not yet published)

[SnowEx20 Grand Mesa Autumn 2019 Snow Pits](#) (not yet published)

6 RELATED WEBSITES

[SnowEx at NSIDC | Overview](#)

[SnowEx at NASA](#)

[NASA SnowEx 2020 Experimental Plan](#)

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8 DOCUMENT INFORMATION

8.1 Publication Date

03 June 2021

8.2 Date Last Updated

03 June 2021

APPENDIX A – SNOWEX GRAND MESA IOP SNOW PIT NAMING CONVENTION DESCRIPTION

The SnowEx Grand Mesa Intensive Observation Period (IOP) 2020 snow pits were used to validate snow remote sensing on Grand Mesa. Snow pits were selected to cover the full range of conditions found on Grand Mesa, from meadows to dense forests and from shallow snow depths to deep snowpack.

Potential Grand Mesa snow conditions were evaluated based on SnowEx 2017 airborne lidar and optical imagery (Figure A1). Specifically, the Airborne Snow Observatory’s 08 February 2017 lidar-derived snow depths ([ASO L4 Lidar Snow Depth 3m UTM Grid, Version 1](#)) were binned into three classes: shallow (<90 cm), intermediate (90-122 cm), and deep (>122 cm). A tree density map created from November 2010 WorldView-2 imagery was also binned into three classes based on the percentage of tree-class pixels within a 50-m radius: treeless (0%), sparse (1-30%), and dense (31-100%). The two factors were combined to form a nine-point snow and tree matrix (Figure A1). Within this matrix, values 1-3, 4-6, and 7-9 represent treeless, sparse, and dense tree areas, respectively. These three ranges can be further subdivided into three categories of snow depth classification: shallow (lowest number in a range, e.g., 1), intermediate, and deep (highest number in a range, e.g., 3). Treeless areas were not split into shrub or meadow cover types. Water bodies and missing lidar data remain unclassified (grey areas in Figure A1).

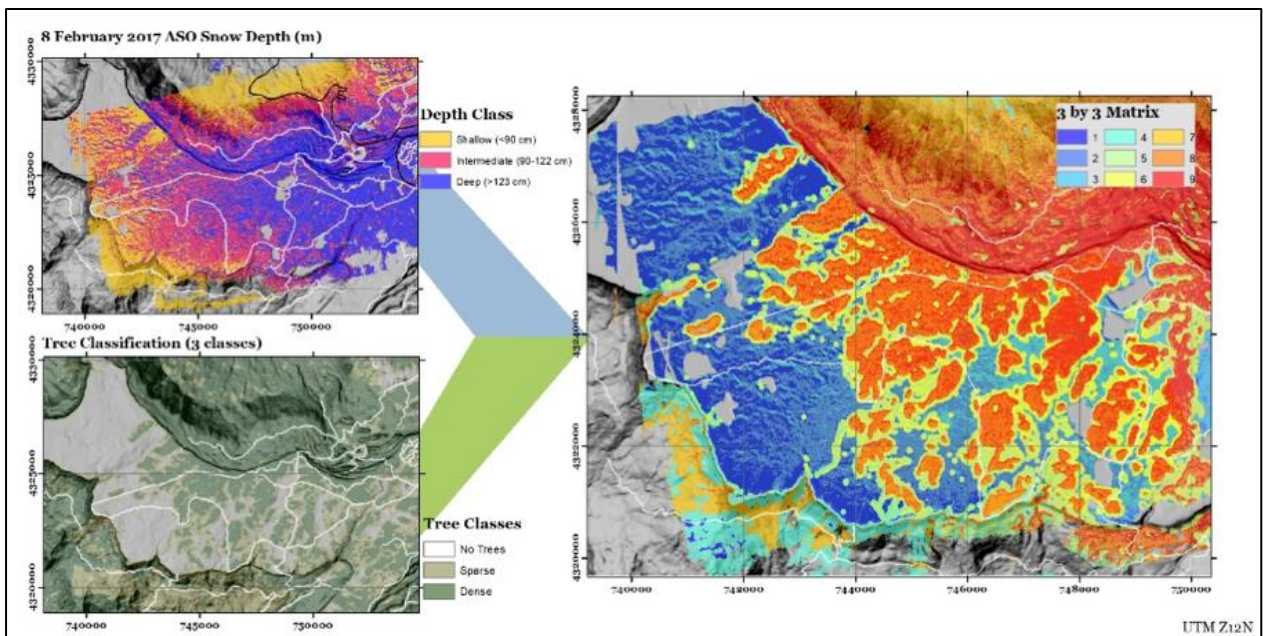


Figure A1. Separate vegetation and snow depth classifications for the Grand Mesa IOP study site are shown (left). These classifications were combined to form the final tree density and snow depth matrix used to describe snow pit locations (right). In all images, gray areas represent undefined regions (e.g., water bodies).

Finally, the Grand Mesa IOP study site was clipped into three flight lines (north, N; south, S; and cross, C) (Figure A2). These flight lines correspond to the scheduled IOP airborne observations.

Within the flight lines, 150 snow pit locations (approximately three weeks of work) were proportionally divided by the nine matrix classes, then randomly distributed amongst the three flight lines for each matrix class (Figure A2). Matrix classes were not evenly represented and varied in frequency; for example, there are 3 class 4 snow pits and 33 class 2 snow pits. Snow pit names use the following convention, as described in Table A1:

<matrix>[FlightLine]##

Table A1. Snow Pit Naming Convention Description

Variable	Description
Matrix	Number describing the measurement site conditions. Each number contains information about the amount of vegetation around the snow pit: <ul style="list-style-type: none"> • 1/2/3 = treeless (0% tree cover) • 4/5/6 = sparse (1-30% tree cover) • 7/8/9 = dense (31-100% tree cover) and the relative, expected snow pit depth: <ul style="list-style-type: none"> • 1/4/7 = shallow snowpack • 2/5/8 = medium snowpack • 3/6/9 = deep snowpack
[FlightLine]	Indicates on which flight line the snow pit resided: <ul style="list-style-type: none"> • N = North • S = South • C = Crossline
##	Pit ID number. Numbers are lowest in the West and North and increase incrementally by whole numbers as you move further East or South along a particular flight line.

For example, Pit “9S40” denotes matrix class 9 (deep snow and dense trees), South flight line, and the 40th total pit on the South line from west to east. Similarly, Pit “1C14” denotes matrix class 1 (shallow snow and no trees), Cross line, and the 14th pit along the Cross line from Northwest to Southeast.

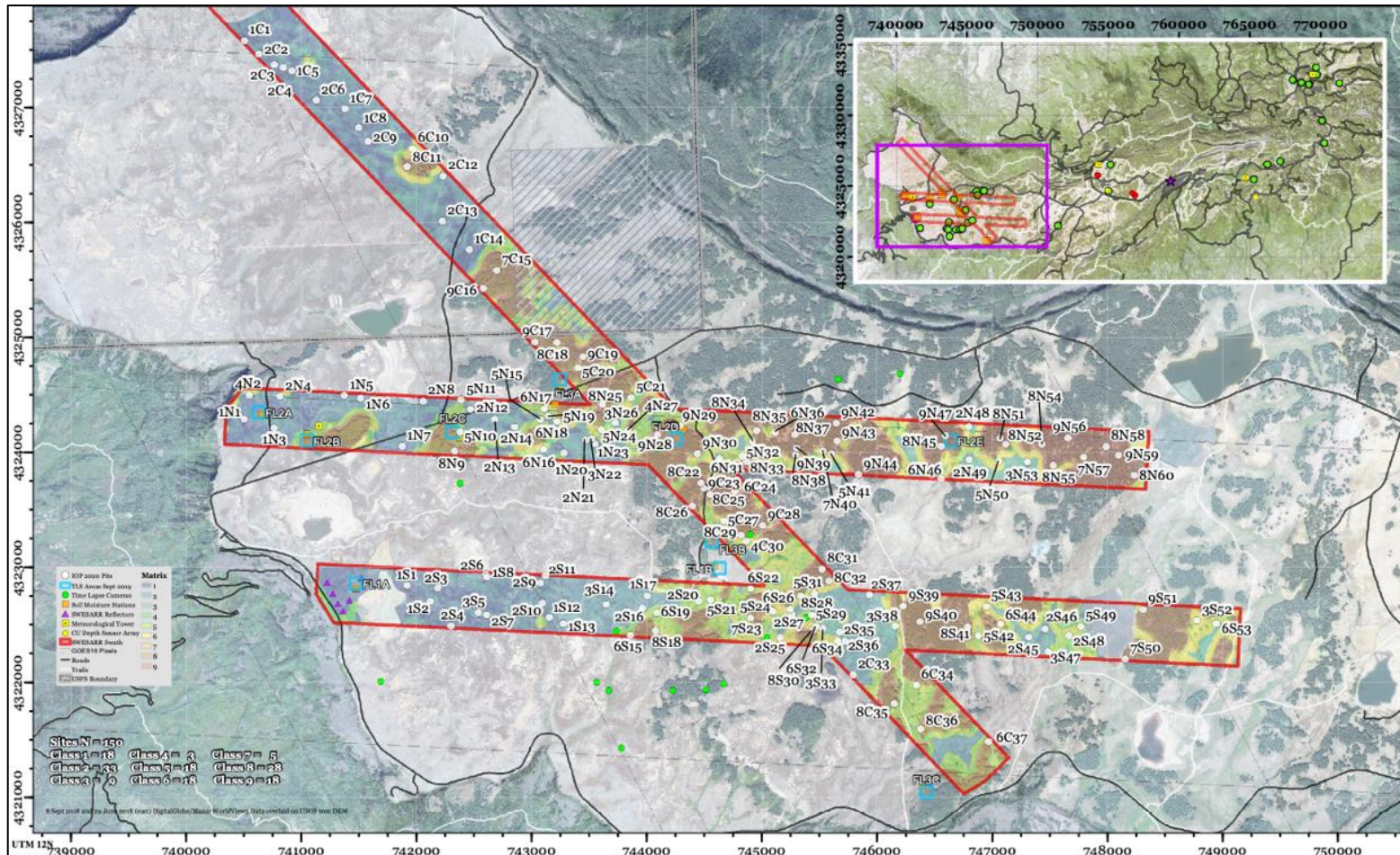


Figure A2. Location of the 150 Grand Mesa IOP snow pits. Snow pits were randomly spaced along the North (upper horizontal line), South (lower horizontal line), and Cross (diagonal line) flight lines, along which airborne measurements were collected. Snow pit naming conventions are described in Table A1. The inset in the top right shows the location of the IOP snow pits and flight lines relative to the rest of Grand Mesa and other SnowEx 2020 locations. Green dots show the location of time lapse cameras, red dots show the location of time series snow pits, yellow squares with black circles show the location of meteorological towers, and yellow circles show the location of snow depth sensors.