SnowEx20 Cameron Pass Ground Penetrating Radar, Version 1

USER GUIDE

How to Cite These Data

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

McGrath, D., R. Bonnell, A. Olsen-Mikitowicz, D. Duncan and J. Grabowski. 2021. *SnowEx20 Cameron Pass Ground Penetrating Radar, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/U4Q3X27BMRR4. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SNEX20_COCP_GPR

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

This data set contains the results of ground-penetrating radar surveys conducted at Cameron Pass, Colorado during the SnowEx20 campaign. Data include two-way travel time, pit-measured snow density, calculated snow depth, and calculated snow water equivalent.

1.2 File Information

1.2.1 Format

All data is collected in a single comma-separated value (.csv) file.

1.2.2 File Contents

The .csv file contains 12 columns with the parameters listed in Table 1.

Table 1. Data Parameters

Name	Description	Unit/Format
Date_mmddyy	Date using six digits representing month, day and last two digits of year	[mmddyy]
Time_HHMMSS	Six digits representing the hour, minute and seconds within the day. For this data set this column is not used and consists of NaNs.	[HHMMSS]
Longitude_deg	Longitude	degree
Latitude_deg	Latitude	degree
Elevation_m	Elevation	m
Easting_m	Easting	m
Northing_m	Northing	m
UTM_Zone	Universal Transverse Mercator time zone	N/A
TwoWayTT_ns	Two way travel time	ns
Density_kg_per_m3	Snow density	kg m^{-3}
Depth_cm	Snow depth	cm
SWE_mm	Snow water equivalent	mm

1.2.3 Naming Convention

The single data file is named `SNEX20_COCP_GPR_12182019_03122020.csv`. `SNEX20_COCP_GPR` refers to the SnowEx 2020 Colorado, Cameron Pass GPR data and `12182019_03122020` represents the start and ending date of the collected data.

1.3 Spatial Information

1.3.1 Coverage

Northernmost Latitude: 40.52º N
Southernmost Latitude: 40.51º N
Easternmost Longitude: 105.88° W
Westernmost Longitude: 105.89° 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
EPSG code	4326
PROJ4 string	+proj=longlat +datum=WGS84 +no_defs
Reference	https://epsg.io/4326

Additionally, to latitude/longitude in WGS 84 (epsg.io/4326) the data file also contains northing/easting in WGS 84 / UTM zone 13N (epsg.io/32613).

1.4 Temporal Information

1.4.1 Coverage

18 December 2019 to 12 March 2020

1.4.2 Resolution

Data was collected along three pre-determined transects that were repeated weekly to monthly coinciding with NASA UAVSAR overflights.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

This data set contains the results of ground-penetrating radar surveys conducted at Cameron Pass, Colorado during the SnowEx20 field campaign. Data were collected between 18 December 2019 and 12 March 2020 along three pre-determined transects that were repeated weekly to monthly coinciding with NASA UAVSAR overflights.

2.2 Acquisition

Ground-penetrating radar (GPR) surveys were conducted using a Sensors and Software PulseEKKO PRO radar system and a shielded 1000 MHz antenna. The control unit and antenna were pulled in a plastic sled behind the operators, who were on snowshoes. Individual GPR traces were geolocated using a Emlid RS2 (L1/L2) GPS receiver that was mounted on the sled.

2.3 Processing

Raw data files were processed using Matlab and ReflexW software. The following steps were applied to process the data:

- Time-zero correction
- Dewow filter
- Subtracting average filter applied over ~60 traces
- Trace resampling to equidistant spacing of ~0.08 m.

The traces had a sample rate of 0.1 ns. The base of the snowpack was manually picked following a consistent positive phase at the snow-ground interface.

GPS measurements were made with an Emlid RS2 receiver operated in post-processed kinematic (PPK) mode. The rover was post-processed in RTKlib using observations from an Emlid RS2 receiver base station at the field site.

Measured two-way travel times were converted to snow depth and snow water equivalent using pit-measured snow densities and an empirically derived radar velocity (Kovacs et al., 1995). Snow density was measured in two pits at different locations within the study area for each survey date.

The snow density/velocity from the nearest pit was applied to the corresponding radar measurements.

2.4 Quality, Errors, and Limitations

The uncertainty of the snow depth is approximately ±3.5 cm. A formal error analysis will be conducted as part of a forthcoming publication.

2.5 Instrumentation

Data were collected using a Sensors & Software pulseEKKO PRO ground penetrating radar (GPR) system and a 1 GHz antenna.

3 SOFTWARE AND TOOLS

The .csv files can be accessed using software that reads ASCII text.

4 VERSION HISTORY

Table 3. Version History Summary

Version	Release Date	Description of Changes
V1	30 March 2021	Initial release

5 RELATED DATA SETS

SnowEx at NSIDC | Data Sets
SnowEx20 Cameron Pass Ground Penetrating Radar Raw

6 RELATED WEBSITES

SnowEx at NSIDC | Overview
SnowEx at NASA

7 CONTACTS AND ACKNOWLEDGMENTS

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8 REFERENCES

Kovacs, A., A. J. Gow & R. M. Morey. (1995). The in-situ dielectric constant of polar firn revisited. Cold Regions Science and Technology, 23(2), 245-256, https://doi.org/10.1016/0165-232X(94)00016-Q.

McGrath, D., R. Webb, D. Shean, R. Bonnell, H. P. Marshall, T. H. Painter, et al. (2019). Spatially extensive ground penetrating radar snow depth observations during NASA's 2017 SnowEx campaign: Comparison with In situ, airborne, and satellite observations. Water Resources Research, 55, https://doi.org/10.1029/2019WR024907.

9 DOCUMENT INFORMATION

9.1 Publication Date

30 March 2021

9.2 Date Last Updated

13 April 2021