SnowEx17 Radiometrics Surface-Based Radiometer Brightness Temperatures, Version 1

USER GUIDE

How to Cite These Data

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

Roy, A., A. Langlois, and L. Brucker. 2019. *SnowEx17 Radiometrics Surface-Based Radiometer Brightness Temperatures, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/JWONK1ZTSBXX. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SNEX17_SBR

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

The main parameters for this data set are shown in Table 1.

Table 1. Parameters

Parameters	Units	Measurement Device	Measurement Site
Brightness temperature (T_b)	kelvins, K	Four surface-based radiometers (SBR) at 89, 37, 19, and 11 GHz	Snow Pits, County Line parking site, MegaTrench
Snow wetness	vol./vol.	Snow Fork	Snow Pits

1.2 File Information

1.2.1 Format

Data are presented in Comma Separated Values (.csv) format. Compressed images (.jpg) are also provided. Both data files (.csv) and images (.jpg) are grouped in zip folders (.zip).

Each data file also has an associated XML file that contains metadata.

1.2.2 File Contents

Brightness temperature data files begin with a nine-line header that describes the file contents, the methods used to collect data, and missing data values. An example of this header is shown in Figure 1. Brightness temperature data are presented in 23 columns, which are described in Table 2.

```
#File : Name of the TBraw file (SnowEx_File_SITE_Position_View_YYYYMMDD_HHMM_MST)
#Pit : Name of the adjacent snowpit (NaN = no adjacent pit)
#Snow Depth : Snow Depth measurements were done with an avalanche probe in the footprint of the radiometer (cm) (NaN = no snow depth measured)
#UTM (12 S and 13S) : UTM coordinates of the SBR footprint (NaN = no GPS point taken during the measurements)
#TBFRP : Averaged calibrated brightness temperature (TB) (over the 2-4 minutes) at a given frequency (FR : 89 - 37 - 19 - 11) and a given polarization (P : horizontal [H] or vertical [V]) in Kelvin (K)
#stdFRP : Standard deviation of the measurements during the 2-4 minute period.
#IDPhoto : Photo ID that were taken at the SBR site (see Picture_SBRTrench directory).
#SnowFork : Identifies if snowfork measurements were taken.
#Comments : General comments on when and where the measurements were conducted.
```

Figure 1. Header for the brightness temperature data file, SnowEx17_SBR_Trench_TBcalibrated.

Table 2. Brightness Temperature Data File Content Descriptions

Column Header	Description
File_SITE_Position_View_ YYYYMMDD_HHMM_MST	Includes the file name for the raw brightness temperature data from which row values were calculated; raw files not archived at NSIDC
PITID	Name of the most adjacent snowpit to the SBR measurements
Snow Depth	Depth of snow at the site of the measurement, in cm; snow depth was measured with an avalanche probe
UTM	Coordinate system
TB*rr*P(K)	Brightness temperature in kelvins (K) at frequency *rr* and polarization P: rr = 89, 37, 19, or 11 P = H (horizontal) or V (vertical)
std*rr*P(K)	The standard deviation for the brightness temperature reading in kelvins (K) at frequency *rr* and polarization P: rr = 89, 37, 19, or 11 P = H (horizontal) or V (vertical)
IDPhoto	Identifies the browse images associated with the SBR measurement site
Comments	General comments on where and how the SBR readings were taken

Continuous data files contain 16 columns of data, described in more detail in Table 3. Figure 2 shows 10 lines of data from the file: `SnowEx17_SBR_Corrected_SnowEx_GM_84N_20170217_1221`.

Table 3. Continuous File Content Descriptions

Column Header	Description
Frequency	Frequency at which SBR measurements were collected (GHz)
Year	Year of data acquisition
Month	Month of data acquisition
Day	Day of data acquisition
Hour	Hour of data acquisition
Minute	Minute of data acquisition
Seconde	Second of data acquisition
$Vload_1$	Internal load observations
$VloadND_1$	Internal load noise diode
$Tload_1$	Radiometer temperature
$Tcase_1$	Case temperature
V (V-Pol) (V)	Voltage at V-pol

Column Header	Description
V (H-Pol) (V)	Voltage at H-pol
Incidence Angle (∞)	Angle at which SBR measurements were collected (measured from the horizontal)
Tb (V-Pol) (K)	Brightness temperature at the vertical polarization (K)
Tb (H-Pol) (K)	Brightness temperature at the horizontal polarization (K)
[1]Raw values taken directly from the instrument, see the Technical References tab for more details	

All times noted are Mountain Standard Time (MST)
#Site ID : 84N
Tb (V-pol) (K) : calibrated brightness temperature (TB) at V-pol
Tb (H-pol (K) : calibrated brightness temperature (TB) at H-pol
Note: The values between Seconde and Tb (V-pol) (K) are radiometer raw data (see readme for more information).

#Frequency (GHz)	Year	Month	Day	Hour	Minute	Seconde	Vload	VloadND	Tload	Tcase	V (V-Pol) (V)	V (H-Pol) (V)	Incidence Angle (∞)	Tb (V-Pol) (K)	Tb (H-Pol) (K)
11	2017	2	17	12	21	38	1.52135	2.01073	40.015	7.67	1.45626	1.42725	-37.789	239.994	206.571
11	2017	2	17	12	21	42	1.52133	2.01077	40.016	7.654	1.45638	1.42756	-37.77	240.172	206.977
11	2017	2	17	12	21	46	1.52113	2.011	40.012	7.678	1.45573	1.42762	-37.765	239.7	207.374
11	2017	2	17	12	21	49	1.52122	2.01094	40.011	7.671	1.45613	1.42717	-37.768	240.044	206.703
11	2017	2	17	12	21	53	1.52157	2.01091	40.004	7.671	1.45638	1.42738	-37.771	239.858	206.445
11	2017	2	17	12	21	57	1.52178	2.01102	40.008	7.679	1.45639	1.42757	-37.777	239.607	206.402
11	2017	2	17	12	21	60	1.52159	2.01124	40.01	7.673	1.4565	1.42731	-37.786	240.031	206.415
11	2017	2	17	12	22	4	1.52133	2.01099	40.006	7.647	1.45652	1.42761	-37.783	240.364	207.076
11	2017	2	17	12	22	7	1.52161	2.01085	40.008	7.674	1.45641	1.42759	-37.772	239.834	206.626
11	2017	2	17	12	22	11	1.5217	2.01094	40.003	7.672	1.45624	1.42806	-37.762	239.52	207.07

Figure 2. Continuous SBR Data Sample File

Snow fork data files begin with a four-row header that specifies the date and time of acquisition, the snowpit ID where measurements were collected, and descriptions of the data columns. Table 4 contains a more detailed description of each data column, and Figure 3 shows sample data from file `SnowEx17_SBR_Snow_Fork_21S_16Feb.csv`.

Table 4. Snow Fork File Content Descriptions

Column Header	Description	Units
Depth	Depth at which the snow fork measurement was taken (v = vertically inserted)	cm
Snow Wetness	Snow fork measurement	vol./vol.
Snow Density	Density of snow	kg / cm^3

```
# Date (MM/DD/YY): 02/16/17
# Mountain Standard Time (HHhMM): 14h15
# Site ID: 21S
# depth(top=0, v=inserted vertically),SnowWetness (vol./vol.),SnowDensity (kg cm-3)
v,0.367,0.2904
5,0.558,0.1292
10,0.877,0.2429
15,1.678,0.2476
20,1.414,0.253
25,0.491,0.2353
30,0.38,0.2756
35,0.873,0.2382
40,0.508,0.2721
45,1.1251,0.2303
50,0.638,0.2748
55,0.624,0.2479
60,0.768,0.2737
65,0.878,0.2447
70,0.745,0.2373
```

Figure 3. Snow Fork Sample File

1.2.3 Directory Structure

Data files and images are provided in zip folders, labeled by measurement site, as shown in Figure 1. See the "File Naming Convention" of this user guide for more details on the files stored within these zip folders.

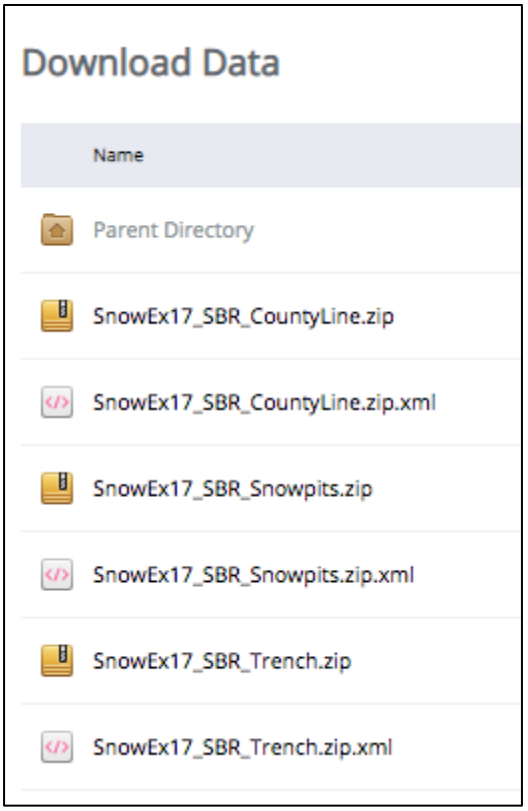

Figure 4. File Directory Structure

1.2.4 Naming Convention

The brightness temperature data files are named according to the following convention and as described in Table 5:

SnowEx17_SBR_<measurement site>_Tbcalibrated.csv

Example:

SnowEx17_SBR_CountyLine_TBcalibrated.csv

Table 5. Brightness Temperature File Naming Convention

Parameters	Measurement Site
SnowEx17_SBR	Abbreviation for SnowEx17 Radiometrics Surface-Based Radiometer Brightness Temperatures
<measurement site>	Where the data were collected (County Line, Snowpits, Trench)

The snow fork data files are named according to the following convention and as described in Table 6:

`SnowEx17_SBR_Snow_Fork_<site ID>_##Feb.csv`

Example:

`SnowEx17_SBR_Snow_Fork_24E_15Feb.csv`

`SnowEx17_SBR_Snow_Fork_21S_16Feb.csv`

Table 6. Snow Fork File Naming Convention

Parameters	Measurement Site
SnowEx17_SBR	Abbreviation for SnowEx17 Radiometrics Surface-Based Radiometer Brightness Temperatures
Snow_Fork	Indicates that this file contains snow fork measurements
<side ID>	Snow pit ID
##Feb	Date of measurement

The continuous data files (where measurements were recorded continuously over approximately 20 minutes) are named according to the following convention and as described in Table 7:

`SnowEx17_SBR_Corrected_SnowEx_GM_<site ID>_YYYYMMDD_hhmm.ext`

Example:

`SnowEx17_SBR_Corrected_SnowEx_GM_32S_20170216_1158.csv`

`SnowEx17_SBR_Corrected_SnowEx_GM_84N_20170217_1221.csv`

Table 7. Continuous Data File Naming Convention

Parameters	Measurement Site
SnowEx17_SBR	Abbreviation for SnowEx17 Radiometrics Surface-Based Radiometer Brightness Temperatures
Corrected_SnowEx_GM	Indicates that the file contains corrected, continuous SBR measurements collected in Grand Mesa, CO
<side ID>	Snow pit ID
YYYYMMDD	Date of measurement, in four-digit year, 2-digit month, 2-digit day format
hhmm	Start time of measure

Images are named according to the following convention and as described in Table 8:

`SnowEx17_SBR_<measurement site>_TB_image_####.jpg`

Example:

`SnowEx17_SBR_Snowpits_TB_image_0899.jpg`

`SnowEx17_SBR_Snowpits_TB_image_0900.jpg`

Table 8. Image Naming Convention

Parameters	Measurement Site
SnowEx17_SBR	Abbreviation for SnowEx17 Radiometrics Surface-Based Radiometer Brightness Temperatures
<measurement site>	Where the data were collected (County Line, Snowpits, Trench)
image_####	Image ID (e.g. image 0899, image 0900)

1.2.5 File Size

Zip folders range in size from approximately 1.5 to 3.2 KB.

CSV files range in size from approximately 0.3 KB to 141 KB.

JPG files range in size from approximately 1.8 MB to 5.0 MB.

The total data volume is approximately 894 MB.

1.3 Spatial Information

1.3.1 Coverage

Grand Mesa, Colorado:

Northernmost Latitude: 39.1° N

Southernmost Latitude: 39.0° N

Easternmost Longitude: 107.8° W

Westernmost Longitude: 108.2° W

1.3.2 Resolution

Brightness temperature readings taken at 89, 37, and 19 GHz had a footprint of approximately 0.6m X 0.6m.

Brightness temperature readings taken at 11 GHz had a footprint of approximately 0.8m X 0.8m.

1.3.3 Geolocation

Data falls within the projected coordinate systems WGS 84 / UTM Zone 12 North and WGS 84 / UTM Zone 13 North, details of which are presented in Table 9.

Table 9. Geolocation Details

Geographic coordinate system	WGS 84	WGS 84
Projected coordinate system	WGS 84 / UTM Zone 12 North	WGS 84 / UTM Zone 13 N
Longitude of true origin	-111	-105
Latitude of true origin	0	0
Scale factor at longitude of true origin	0.9996	0.9996
Datum	WGS 1984	WGS 1984
Ellipsoid/spheroid	WGS 84	WGS 84
Units	meters	Meters
False easting	50000	50000
False northing	0	0
EPSG code	32612	32612
PROJ4 string	+proj=utm +zone=12 +datum=WGS84 +units=m +no_Defs	+proj=utm +zone=13 +datum=WGS84 +units=m +no_defs
Reference	https://epsg.io/32612	https://epsg.io/32613

NOTE: Data files indicate that all coordinates fall within Universal Transverse Mercator (UTM) Grid Zone 12S or UTM Grid Zone 13S. These designation correspond to the intersection of latitudinal projection zone S and longitudinal projection zone 12 or 13, as shown in Figure 2.

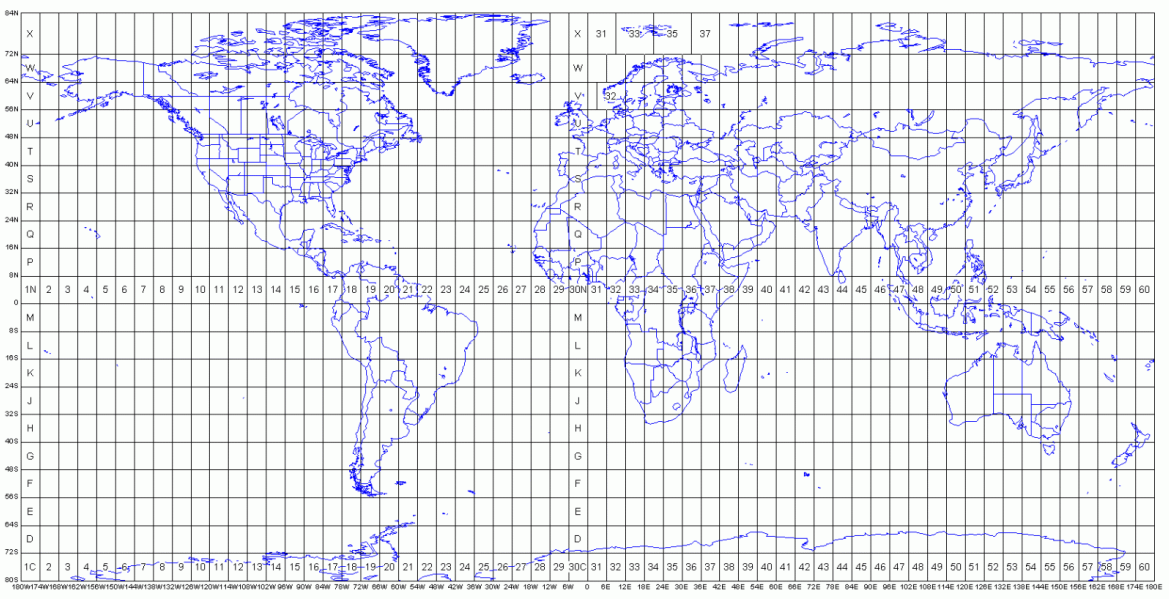

Figure 5. UTM Grid Zone

1.4 Temporal Information

1.4.1 Coverage

Data were acquired between 14 February 2017 and 18 February 2017.

1.4.2 Resolution

N/A

2 DATA ACQUISITION AND PROCESSING

2.1 Background

Snow Water Equivalent (SWE) is often estimated from Satellite Passive Microwave (PMW) observations of brightness temperature (Tb) using algorithms which assume a linear relationship between SWE and spectral Tb. However, seasonal variability in snow grain metamorphism and vegetation can produce variabilities that are not captured in these calculations. As an improvement on PMW algorithms, Microwave Snow Emission Models (MSEM) account for multiple sources of spectral Tb measurements (e.g. water, vegetation) and adjust for inter-annual variability in snow

and vegetation quality. However, MSEM are limited by the coarseness of satellite-scale measurements, which typically have a spatial resolution greater than 10 km X 10 km.

As an alternative to satellite observations of Tb, Surface-Based Radiometers (SBR) offer a better means of isolating and measuring microwave emissions from snow-covered surfaces. SBR readings were incorporated into the 2017 SnowEx campaign in Grand Mesa, CO to quantify the relative importance of different geophysical parameters (e.g. SWE, snow grain) and identify the small-scale spatial variability in Tb measurements.

2.2 Acquisition

2.2.1 SBR Measurements

Four surface-based radiometers (SBR) attached to a sleigh and pulled behind a snow mobile collected brightness temperature (Tb) measurements of snow surfaces and vegetation around Grand Mesa, Colorado. The SBR, mounted approximately 1.5 m off the ground and at an angle of 55°, measured Tb at 89, 37, 19, and 11 GHz in both the vertical (V-pol) and horizontal (H-pol) polarizations. Measurements were taken every six seconds over two- to four-minute intervals at each site. The 89, 37, and 19 GHz SBR had a beamwidth of 6° and a footprint of 0.6 m X 0.6 m., while the 11 GHz SBR had a beamwidth of 8° and a footprint of 0.8 m X 0.8 m.

On 14 Feb. 2017, SBR measurements were collected at two Local Scale Observation Site (LSOS) locations, one close to the radar (RS) and one close to the Michigan radiometers (JC).

Between 15 Feb. and 17 Feb. 2017, measurements were conducted at 29 Grand Mesa (GM) Snow Pit locations.

On 18 Feb. 2017, the SBR measured emissions from the snow surface and the forest (SBR positioned at 55°, looking at the sky and vegetation) behind two Mega Trenches (LSOS_MegaTrenchAspen and LEP_MegaTrench). Measurements were also done at the County Line parking area on a scissor lift. The scissor lift was placed at two heights, 970 cm and 1240 cm. At both heights, the SBR measured Tb from three footprints, one open area (S1) and two forested areas (S2, S3).

2.2.2 Continuous SBR Measurements

During periods of surface melt, continuous SBR measurements were collected over approximately 20 minutes at three snow pits (32S, 97S, and 84N). Continuous measurements quantify how Tb increases as the liquid water content of the snow increases.

2.2.3 Snow Fork Measurements

Between February 15 and February 18 2017, a snow fork was used to measure wetness (% vol) and snow density (kg/cm3) at 13 snow pits.

2.3 Processing

SBR were calibrated with liquid nitrogen (LN_2) and an ambient black body (BB) on 18 February 2017. Calibration coefficients, optimized using the LN_2 and ambient BB measurements, were then used to correct T_b measurements over the whole campaign.

2.4 Quality, Errors, and Limitations

During the campaign, several ambient BB measurements were recorded to quantify the radiometers' stability. The mean absolute error between the radiometers' measurements and physical measurements of the BB was around 1 K. Errors are slightly higher (~1.4 K) for the 37 GHz Tb measurements, specifically those done at LSOS-JCTruck site on 14 Feb. 2017, where a more than 5 K difference between Tb and BB temperature was noted. Caution should be taken when using those 37 GHz observations. All other Tb measurements are reliable within ±1 K.

Biases are under 1 K for all radiometers.

2.5 Instrumentation

2.5.1 Description

The SBR used for this study were all PR-Series radiometers produced by Radiometris Corporation:

- PR-1065: 10.65 GHz dual-polarization, single-channel radiometer
- PR-1900: 19 GHz dual-polarization, single-channel radiometer
- PR-3700: 36.5 GHz dual-polarization, single-channel radiometer
- PR-8900: 89 GHz dual-polarization, single-channel radiometer

Visit the Radiometris Corporation website for more details.

3 RELATED DATA SETS

Other SnowEx Data Sets

4 RELATED WEBSITES

NASA SnowEx

5 CONTACTS AND ACKNOWLEDGMENTS

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6 REFERENCES

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Roy, A., A. Royer, O. St-Jean-Rondeau, B. Montpetit, G. Picard, N. Marchand, and A. Langlois. 2016. Microwave snow emission modeling uncertainties in boreal and subarctice environments. The Crysophere 10: 623-638.

Roy, A., A. Royer, J. P. Wigneron, A. Langlois, J. Bergeron, and P. Cliche. 2012. A simpler parameterization for a boreal forest radiative transfer model at microwave frequencies. Remote Sensing of the Environment 124. https://dx.doi.org/10.1016/j.rse.2012.05.020

7 DOCUMENT INFORMATION

7.1 Publication Date

05 July 2018

7.2 Date Last Updated

14 March 2019