SnowEx20 COSMOS Rover Soil Moisture, Version 1

USER GUIDE

How to Cite These Data

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

Lewis, M. and A. Fisher. 2021. *SnowEx20 COSMOS Rover Soil Moisture, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/UNXN7V6J7OM0. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SNEX20_CRSM

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

This data set contains the raw and processed data files from a COSMOS Rover soil moisture probe. The parameters for the raw data are listed in Table 1 and the parameters of the processed data are listed in Table 2.

Table 1. Raw Data Parameters

Parameter	Description
RecordNum	Record number
Date Time (UTC)	Date time in yyyy-mm-ddThh:mm:ssZ format (e.g. 2019-11-04T16:05:46Z)
PTB110_mb	Atmospheric pressure in mbar (gauge 1)
P1_mb	Atmospheric pressure in mbar (gauge 2)
T1_C	Temperature recorded outside the instrument case in °C
RH1	Relative humidity recorded outside the instrument case
T_CS215	Temperature from optional external sensor – inoperative, all values are -99
RH_CS215	Relative humidity from optional external sensor – inoperative, all values are -99
Vbat	Battery voltage – inoperative, all values are -99
N1Cts	Tube 1 counts
N2Cts	Tube 2 counts
N1ETsec	Tube 1 time in seconds
N2ETsec	Tube 2 time in seconds
N1T(C)	Temperature recorded inside the instrument case in °C
N1RH	Relative humidity recorded inside the instrument case
LatDec	Latitude
LongDec	Longitude
Alt	Altitude

Table 2. Processed Data Parameters

Parameter	Description
Date Time (UTC)	Date time in yyyy-mm-ddThh:mm:ssZ format (e.g. 2019-11-04T16:05:46Z)
LatDec	Latitude
LongDec	Longitude
SM (mm3/cm3)	Volumetric soil moisture

1.2 File Information

1.2.1 Format

Each day of measurements has a separate .csv file for the raw and processed data.

1.2.2 File Contents

The raw data files contain 18 columns with the parameters listed in Table 1 and the processed data files contain 4 columns with the parameters listed in Table 2.

1.2.3 Naming Convention

Data files utilize the following naming convention which is described in Table 3:

`SNEX20_CRSM_DDMMMYYYY_LX.csv`

Table 3. File Naming Convention

Variable	Description
SNEX20_CRSM_	SnowEx 2020 COSMOS rover soil moisture probe data
DDMMYYYY	Date of measurements
LX	L1/L2 for raw/processed data
.csv	File extension

Examples:

- `SNEX20_CRSM_04112019_L1.csv`
- `SNEX20_CRSM_04112019_L2.csv`

1.3 Spatial Information

1.3.1 Coverage

Northernmost Latitude: 39.04º N
Southernmost Latitude: 39.00º N
Easternmost Longitude: 108.09° W
Westernmost Longitude: 108.23° W

1.3.2 Resolution

600 m

1.3.3 Geolocation

The following table provides information for geolocating this data set.

Table 4. Geolocation Details

Geographic coordinate system	WGS 84
EPSG code	4326
PROJ4 string	+proj=longlat +datum=WGS84 +no_defs
Reference	https://epsg.io/4326

1.4 Temporal Information

1.4.1 Coverage

04 November 2020 to 07 November 2020

1.4.2 Resolution

One minute

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The COsmic-ray Soil Moisture Observing System (COSMOS) measures soil moisture via counting of neutrons. Cosmic rays, i.e., high-energy subatomic particles, originating in outer space generate fast neutrons once they penetrate the atmosphere and interact with atmospheric nuclei. Additional neutrons are generated when the cosmic rays interact with the land surface. The produced fast neutrons collide with other atoms in the air and soil, but only if they collide with H atoms, they lose their kinetic energy efficiently as they are similar in mass. As H atoms in the land surface are mostly present in the form of soil moisture, the fast neutron intensity above the land surface is inversely correlated with soil moisture. For more details on the theoretical basis for measuring soil moisture by fast neutron detection, see Dong et al. (2014).

2.2 Acquisition

During the SnowEx 2020 campaign, the COSMOS rover was deployed in an attempt to characterize total moisture in the surface to compare against other sensors. The COSMOS rover was driven over the flight line region of Grand Mesa but was restricted to roads. Often a COSMOS Rover campaign consists of vast swaths being covered by the vehicle for regional surfaces or

tightly overlapping paths for local disaggregation to high-resolution data surfaces. Unfortunately, the road structure on the mesa did not allow for large swaths of parallel and perpendicular crossover, nor did the land use permit the vehicle to drive over grasslands. Therefore, only the paved and gravel roads on the mesa were captured. The data were not corrected for roads in this data set. Data collected at the mesa escapement showed negative soil moisture due to missing surface and will need further study. Please see Schrön et al. (2017) for more information on road corrections for COSMOS Rover data.

2.3 Processing

All read periods below 60 seconds were removed. The calibration was done by vicarious method with a stationary COSMOS sensor. Air pressure correction and water vapor correction was performed using on-site tower data, while neutron intensity corrections utilize data from the Jungfraujoch neutron monitor.

2.4 Quality, Errors, and Limitations

As COSMOS measurement uncertainty is a function of time, the 1-minute readings provide a variable response to soil moisture that fit the Poisson distribution. Several readings are concurrent that may be used for disaggregation or error estimation. Biomass density and neutron density flux also introduce a reading error for soil moisture when not reconciled with the underlying data. These data not corrected for biomass and use a daily average neutron flux.

2.5 Instrumentation

A typical stationary COSMOS probe consists of two neutron detectors with different energy sensitivities, one is sensitive to fast neutrons and the other to thermal neutrons. The detectors are mounted on a pole approximately one meter above the soil surface. The horizontal footprint of a COSMOS probe is dependent on atmospheric pressure and atmospheric water vapor. At sea level the horizontal footprint is ~600 m. The effective measurement depth is ~76 cm. See more details on the instrumental setup in Dong et al. (2014).

While COSMOS stations allow to study the temporal evolution of soil moisture in the footprint, a COSMOS rover can measure spatial variability of soil moisture. The COSMOS rover consists of an array of neutron detectors mounted on a vehicle and its data can be useful for calibration and validation of satellite microwave remote sensing approaches of measuring soil moisture (Dong et al., 2014).

3 SOFTWARE AND TOOLS

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

4 VERSION HISTORY

Table 5. Version History Summary

Version	Release Date	Description of Changes
1	04 Feb 2021	Initial release

5 RELATED DATA SETS

SnowEx at NSIDC | Data Sets

SnowEx 20 stationary COSMOS soil moisture data set

6 RELATED WEBSITES

SnowEx at NSIDC | Overview

SnowEx at NASA

7 CONTACTS AND ACKNOWLEDGMENTS

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8 REFERENCES

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Schrön, M., R. Rosolem, M. Köhli, L. Piussi, I. Schröter, J. Iwema, S. Kögler, S.E. Oswald, U. Wollschläger, L. Samaniego, P. Dietrich and S. Zacharias. 2018. Cosmic-ray Neutron Rover Surveys of Field Soil Moisture and the Influence of Roads, *Water Resources Research* 54,9:6441-6459. doi: 10.1029/2017WR021719.

9 DOCUMENT INFORMATION

9.1 Publication Date

February 2021

9.2 Date Last Updated

February 2021