



# SMAPVEX15 Probe-Based In Situ Soil Moisture Data, Version 1

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## USER GUIDE

### How to Cite These Data

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

Cosh, M. 2018. *SMAPVEX15 Probe-Based In Situ Soil Moisture Data, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. <https://doi.org/10.5067/QTDS3ZGQNM95>. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT [NSIDC@NSIDC.ORG](mailto:nsidc@nsidc.org)

FOR CURRENT INFORMATION, VISIT <https://nsidc.org/data/SV15PSM>



National Snow and Ice Data Center

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# 1 DATA DESCRIPTION

This data set contains in situ soil moisture, bulk density, and soil temperature measurements collected for the [Soil Moisture Active Passive Validation Experiment 2015 \(SMAPVEX15\)](#). Sampling was performed at field sites approximately 1 m apart.

## 1.1 Parameters

Details regarding parameters are listed in Table 1.

Table 1. Parameter Details

Parameter	Range of Valid Values	Unit of Measurement	Sensor
Gravimetric soil moisture (GSM)	0.00330943188086042 - 0.195606140815246	kg/m <sup>3</sup>	N/A: collected manually
Volumetric soil moisture (VSM)	0.00562603419746272 - 0.288957046759557	m <sup>3</sup> /m <sup>3</sup>	Theta Probe
Bulk density (BD) estimate	1.16 - 1.80	kg/m <sup>3</sup>	N/A; calculated using VSM = GSM x BD
Soil temperature at 5 cm	18.2 - 36.4	°C	Theta Probe
Soil temperature at 15 cm	21.3 - 38.2	°C	Theta Probe

## 1.2 File Information

### 1.2.1 Format and File Contents

Table 2 describes the columns of the Microsoft Excel data file, `SMAPVEX15_GVSM_v2.xls`. An Extensible Markup Language (XML) metadata file accompanies the data file.

The file named `SMAPVEX15_GVSM_GEOLOCATION_V3.xls` contains geolocation information for each field site. Note that the column labeled SMAPVEX15 Site lists the field sites used for this experiment, which include a combination of permanent and temporary stations. Figure 1 shows the field site locations. The columns `I_East` and `I_North` in this file refer to Universal Transverse Mercator (UTM) Zone 12N easting and northing coordinates.

Table 2. Description of Columns and Contents in SMAPVEX15\_GVSM\_v2.xls

Column Heading	Description
Date	1- to 2-digit month, 1- to 2-digit day, 4-digit year (MM/DD/YYYY)
Site	Field site number
Time	Sampling time in local time
Theta Probe Reading, %	Theta Probe reading, position 1
	Theta Probe reading, position 2
	Theta Probe reading, position 3
Theta Probe mV	Theta Probe millivolt reading , position 1
	Theta Probe millivolt reading, position 2
	Theta Probe millivolt reading, position 3
Calibrated Theta Probe, in %	Theta Probe factory calibrated reading, position 1
	Theta Probe factory calibrated reading, position 2
	Theta Probe factory calibrated reading, position 3
Temp, 5 cm	Soil temperature at 5 cm depth
Temp, 15 cm	Soil temperature at 15 cm depth
Wet Wgt (g)	Weight of wet soil sample in grams
Dry Wgt (g)	Weight of dry soil sample in grams
GSM (kg/m3)	Gravimetric soil moisture in grams of water per kilograms of dry soil
sample BD (kg/m3)	Bulk density in kilograms
VSM (m <sup>3</sup> /m <sup>3</sup> )	Volumetric Soil Moisture in m <sup>3</sup> /m <sup>3</sup> at 0-5 cm depth

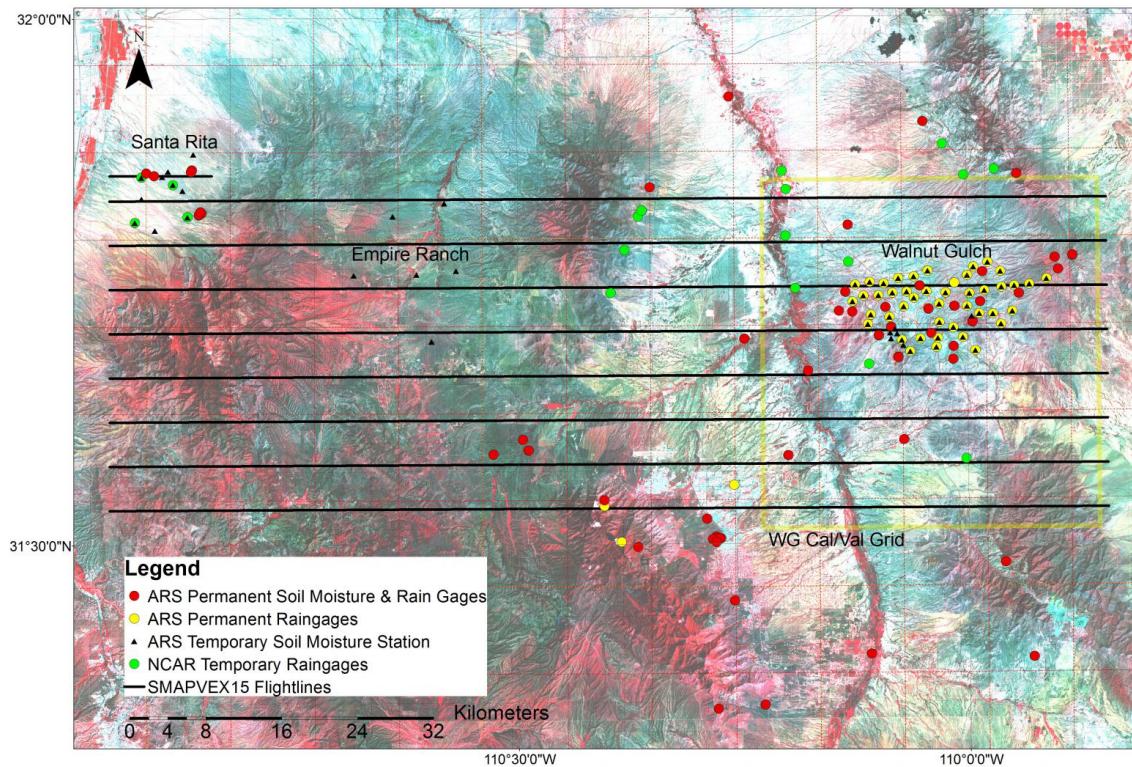


Figure 1. SMAPVEX15 Field Site Locations (See Appendix A for larger version)

ARS in the legend above refers to Agricultural Research Service, a division of the United States Department of Agriculture, and NCAR to the National Center for Atmospheric Research. In the files, site abbreviations include AZ (Arizona), ER (Empire Ranch), RG (Rain Gauge), and SR (Santa Rita).

## 1.2.2 Naming Convention

File names are:

SV15PSM\_SMAPVEX15\_GVSM\_v2.xls

SV15PSM\_SMAPVEX15\_GVSM\_GEOLOCATION\_V3.xls

SV15PSM is the Data Set ID and GVSM indicates gravimetric/volumetric soil moisture.

## 1.3 Spatial Information

### 1.3.1 Coverage

Southernmost Latitude: 31.34351987°N

Northernmost Latitude: 31.92451386°N

Westernmost Longitude: 110.2639881°W

Easternmost Longitude: 110.0483274°W

### 1.3.2 Resolution

Sampling was performed at field sites approximately 1 m apart.

### 1.3.3 Geolocation

Data are provided in Universal Transverse Mercator (UTM) World Geodetic System 1984 (WGS84) coordinates. The EPSG code is [32612](#).

## 1.4 Temporal Information

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Data were collected every two to three days from 02 through 18 August 2015.

# 2 DATA ACQUISITION AND PROCESSING

### 2.1 Site Sampling

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Sampling was performed at many locations in the domain, with low resolution at any single site, which was usually co-located with a precipitation and/or a soil moisture station.

### 2.2 Gravimetric Sampling

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One gravimetric sample was taken with a scooping tool at each field site. In the laboratory researchers weighed the wet soil obtained in the field, heated the soil in an oven to dry it, then weighed the dry soil.

### 2.3 Theta Probes

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Investigators used theta probes to measure surface volumetric soil moisture and soil temperature. The probes were Type ML2 and ML3 manually-operated impedance instruments manufactured by Delta-T Devices, Ltd. The theta probes have four separate 6 cm stainless steel rods inserted vertically into the soil. Each instrument was connected to a handheld reader, which delivers the electrical pulse, detects the return signal, and converts the period to voltage between 0 V and about 1 V. Watershed surface soil moisture was sampled from approximately 6:00 a.m. to 10:00 a.m. local time during the experiment.

The software provided by the probe manufacturer calibrates the theta probes by calculating an estimate of volumetric soil moisture according to the following equation:

$$\text{Theta} = (1.07 + 6.4*V - 6.4*V2 + 4.7*V3 - a_0)/a_1$$

where  $a_0$  and  $a_1$  are 1.6 and 8.4, respectively. These estimates are provided in the data file.

Researchers also performed site-specific calibration for each field of sampling. Theta probe voltage readings from a row sampling point were compared to the volumetric soil moisture measured at the same point. A regression relationship was developed and new volumetric soil moisture values were estimated. When possible, data from the [Soil Moisture Experiments in 2004 \(SMEX04\)](#) were added to this regression for increased data records.

## 2.4 Computing Volumetric Soil Moisture and Bulk Density

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Samplers also used the following steps to compute volumetric soil moisture and bulk density:

- Compute the gravimetric soil moisture (GSM) and dry mass
- Divide the dry mass of the soil by the volume of the cylinder to obtain the bulk density (BD)
- Compute volumetric soil moisture (VSM):  
$$VSM = GSM \times BD$$

## 2.5 Quality, Errors, and Limitations

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### 2.5.1 Bulk Density Error Sources

An excavation method was used at most sampling sites to gain a bulk density estimate. As bulk density does not change significantly in this region, some measurements were recalled from 2004 during the [Soil Moisture Experiment 2004 \(SMEX04\)](#) campaign. The scooping tool used for this experiment does not allow for a bulk density estimate, so a separate bulk density was applied to the gravimetric samples to produce a volumetric soil moisture estimate.

### 2.5.2 Theta Probe Error Sources

For various reasons, including extremely dry conditions, severe weather restrictions, miscommunication among personnel, and cultivation, some sites were not sampled on particular days. Occasionally, a probe rod was damaged due to very hard and dry soil conditions. When possible, the broken rod was replaced. When it was not possible to replace the rod, a new theta probe was used.

### 2.5.3 Quality

The quality of the data corresponds to the quality of the soil moisture measurements carried out in similar soil moisture field experiments.

## 2.6 Instrumentation

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For sensors used to collect these data, see the Parameters section.

## 3 SOFTWARE AND TOOLS

A spreadsheet program such as Microsoft Excel is recommended to view these data.

## 4 CONTACTS AND ACKNOWLEDGMENTS

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### 4.1 Acknowledgments:

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## 5 REFERENCES

Cosh, M. H., T. J. Jackson, R. Bindlish, J. S. Famiglietti, and D. Ryu. 2005. A comparison of soil moisture impedance probe calibration techniques, *Journal of Hydrology*. 31(1-4): 49-58.

## 6 DOCUMENT INFORMATION

### 6.1 Publication Date

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March 2018

### 6.2 Date Last Updated

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February 2025

## APPENDIX A – SMAPVEX15 FIELD SITE LOCATIONS

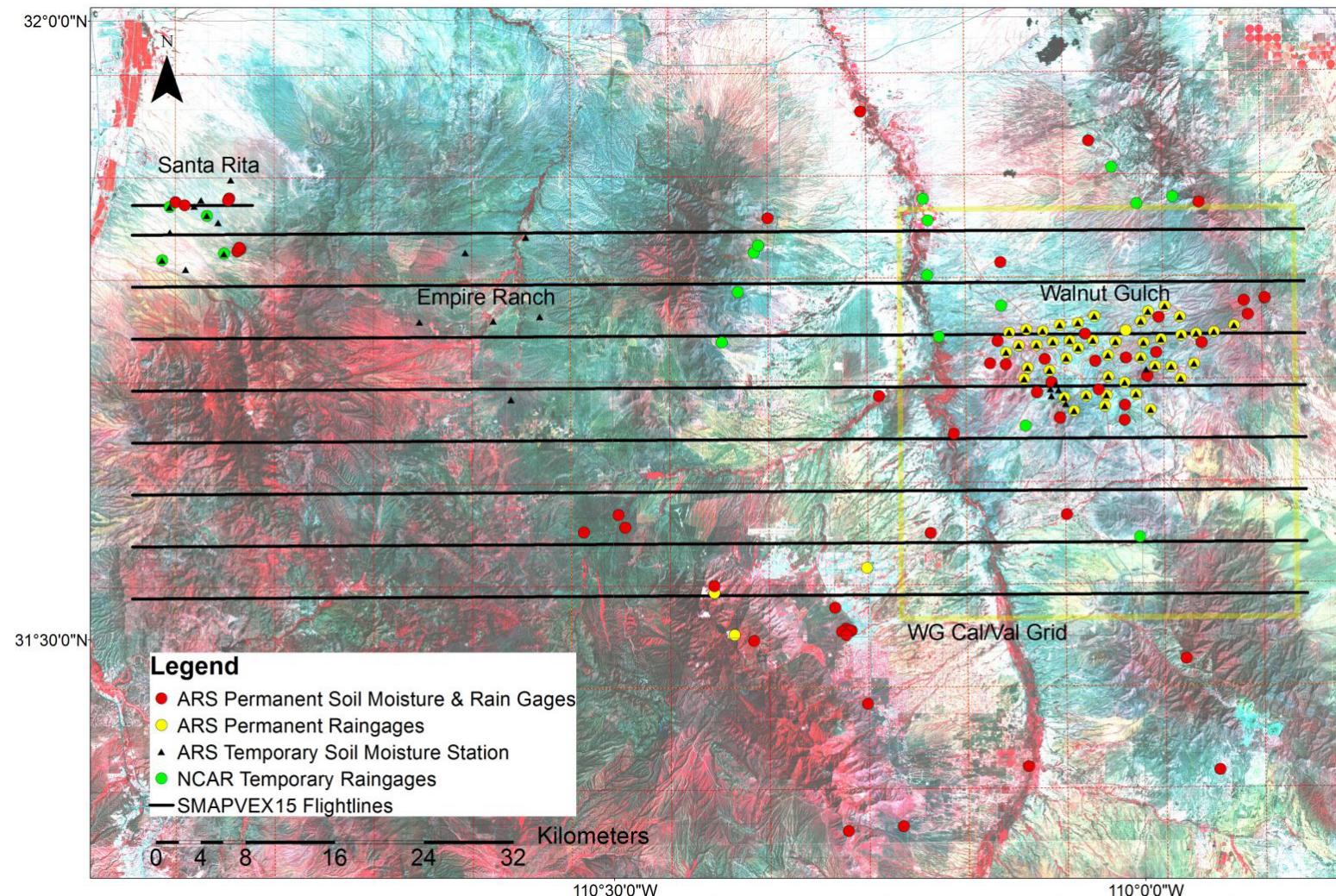


Figure A - 1. SMAPVEX15 Field Site Locations: ARS in the legend above refers to Agricultural Research Service, a division of the United States Department of Agriculture, and NCAR to the National Center for Atmospheric Research. In the files, site abbreviations include AZ (Arizona), ER (Empire Ranch), RG (Rain Gauge), and SR (Santa Rita).