SMAP/In Situ Core Validation Site Land Surface Parameters Match-Up Data, Version 1

USER GUIDE

How to Cite These Data

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

Colliander, A., J. Asanuma, A. Berg, T. Bongiovanni, D. Bosch, T. Caldwell, C. Holifield - Collins, K. Jensen, et al. 2017. *SMAP/In Situ Core Validation Site Land Surface Parameters Match-Up 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/DXAVIXLY18KM. [Date Accessed].

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National Snow and Ice Data Center

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1 DATA DESCRIPTION

SMAP radiometer and radar soil moisture data products are matched with *in situ*-based soil moisture estimates from core validation sites to produce this data set. These data provide performance assessments of various SMAP soil moisture products. The SMAP radiometer and radar soil moisture retrieval algorithms are described in corresponding Algorithm Theoretical Basis Documents (ATBD).

The SMAP products matched with *in situ* data are:

- SMAP L2 Radiometer Half-Orbit 36 km EASE-Grid Soil Moisture (SPL2SMP)
- SMAP L2 Radar Half-Orbit 3 km EASE-Grid Soil Moisture (SPL2SMA)
- SMAP L2 Radar/Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture (SPL2SMAP)
- SMAP Enhanced L2 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture (SPL2SMP_E)

This data set is part of a broader SMAP Calibration/Validation (Cal/Val) Program. Please visit the SMAP Cal/Val Activities website for more details.

1.1 Parameters

Parameters for this data set are surface soil moisture (0-5 cm) in m^3/m^3 and surface soil temperature (0-50) in °C.

1.2 File Information

1.2.1 Format

Data are provided in ASCII text (`.txt`).

Extensible Markup Language (`.xml`) files with associated metadata are also provided.

1.2.2 File Contents

Table 1 lists the information necessary to identify the contents of the data files, such as SMAP product IDs, versions, and Composite Release IDs (CRIDs).

CRIDs indicate processing changes (such as algorithm and software) shared by a particular version. Note that major versions (Version 3, for example) can have multiple CRIDs. Refer to the SMAP Data Versions page for more information on versions and CRIDs.

Table 1. File Subdirectories, Contents, Versions, and CRIDs

SMAP Product ID	SMAP ID in File Names for this Product	Version	CRID in this Match-Up Product[1]	CRID(s) in Operational SMAP Products[2]	Assessment Reports[3]
SPL2SMP	SMAPL2SMP	Version 3	T12323	R13080	Report
SPL2SMP	SMAPL2SMP	Version 4	R13080	R14010, R15060, R15152, R15180, R15181, R15182	Report
SPL2SMP	SMAPL2SMP	Version 5	T15600	R16000, R16010	Report
SPL2SMP	SMAPL2SMP	Version 6	T16500	R16510	Report
SPL2SMP_E	SMAPL2SMPE	Version 1	D14000	R14010, R15060, R15152, R15180, R15181, R15182	Report
SPL2SMP_E	SMAPL2SMPE	Version 2	R16010	R16000, R16010	Report
SPL2SMP_E	SMAPL2SMPE	Version 3	R16510	R16510	Report
SPL2SMP_E	SMAPL2SMPE	Version 4	T16700	R17000	Report
SPL2SMP_E	SMAPL2SMPE	Version 5	T17350	R18240	Report
SPL2SMA	SMAPL2SMA	Version 3	T12400	R13080	Report
SPL2SMAP	SMAPL2SMAP	Version 3	D12000	R13080	Report
SPL2SMAP_S	SMAPL2SMSP9km	Version 3	R17000	R17030	Report

[1] CRIDs in this product are usually different than those in SMAP operational products (e.g. SPL2MP). To generate this match-up product, a separate offline (non-operational) processor is used for validation grid processing; this results in separate, corresponding CRIDs.

[2] The SMAP Data Versions page lists CRIDs used in operational SMAP products only.

[3] Match-up files correspond to the data used in the assessment reports.

Table 2 describes the fields contained in the data files.

Table 2. Description of Data Fields

Data Field	Unit	Valid Range	Definition	Description	Source
ID	N/A	N/A	Reference pixel ID	Unique ID of the reference pixel	N/A
Yr	N/A	N/A	Year	N/A	N/A
Mo	N/A	N/A	Month	N/A	N/A
Day	N/A	N/A	Day	N/A	N/A
Hr	N/A	N/A	Hour	N/A	N/A
Min	N/A	N/A	Minute	N/A	N/A
TOY	N/A	N/A	Time of Year	Fractional day of year, where 01 January is 1 and 31 December is 365 (non leap year)	N/A
WASM	m^3/m^3	0-0.6	Weighted Average Soil Moisture of reference pixel	Obtained from the sensors deployed within the SMAP reference pixel area; includes arithmetic average and weighted average; weighting scheme independently decided for each pixel (default approach is Voronoi diagrams); soil moisture measurements are taken at a depth of 0-5 cm	*In-situ*
ASM	m^3/m^3	0-0.6	Average Soil Moisture of reference pixel	Obtained from the sensors deployed within the SMAP reference pixel area	*In-situ*
WAST	°C	0-50	Weighted Average Soil Temperature of reference pixel	Obtained from the sensors deployed within the SMAP reference pixel area; includes arithmetic average and weighted average; weighting scheme independently decided for each pixel (default approach is Voronoi diagrams)	*In-situ*
AST	°C	0-50	Average Soil Temperature of reference pixel	Obtained from the sensors deployed within the SMAP reference pixel area	*In-situ*
sWASM	m^3/m^3	0-0.2	Standard deviation of Weighted Average Soil Moisture of reference pixel	Used in computing the averages WASM and ASM. For weighted average, the weights are accounted for in the computation of the standard deviation	N/A
sASM	m^3/m^3	0-0.2	Standard deviation of Average Soil Moisture of reference pixel	Non-weighted standard deviation	N/A
NUM	N/A	N/A	Number of sensors used to compute average	N/A	N/A

Data Field	Unit	Valid Range	Definition	Description	Source
Q-RP	N/A	0=valid; 1=invalid	Reference pixel quality flag	Each in situ sensor is quality controlled. During the averaging process, these quality flags are aggregated to determine whether the averaged value is ok. If less than 10% of the contributing stations (after weighting) are compromised, the value is deemed valid (0) otherwise invalid (1).	N/A
SM-1	m^3/m^3	0-0.6	SMAP soil moisture	Refer to Table 3	SMAP
Q-FLG-1	N/A	N/A	SMAP retrieval quality flag	Can convert to a 16-bit binary to retrieve the individual flag values1. Refer to Table 3	SMAP
Tsurf (°C)	N/A	0-50	Surface Temperature from SMAP product	Model-based soil temperature from the Global Modeling and Assimilation Office (GMAO) for estimating effective surface temperature and computing emissivity	SMAP
S-FLG	N/A	N/A	SMAP surface flag	Can convert to a 16-bit binary to retrieve the individual flag values1. Refer to the SPL2SMP user guide for more information.	SMAP
SM-2	m^3/m^3	0-0.6	SMAP soil moisture	Refer to Table 3	SMAP
Q-FLG-2	N/A	N/A	SMAP retrieval quality flag	Can convert to a 16-bit binary to retrieve the individual flag values1. Refer to Table 3	SMAP
SM-3	m^3/m^3	0-0.6	SMAP soil moisture	Refer to Table 3	SMAP
Q-FLG-3	N/A	N/A	SMAP retrieval quality flag	Can convert to a 16-bit binary to retrieve the individual flag values1. Refer to Table 3	SMAP
SM-4	m^3/m^3	0-0.6	SMAP soil moisture	Refer to Table 3	SMAP
Q-FLG-4	N/A	N/A	SMAP retrieval quality flag	Can convert to a 16-bit binary to retrieve the individual flag values1. Refer to Table 3	SMAP
SM-5	m^3/m^3	0-0.6	SMAP soil moisture	Refer to Table 3	SMAP
Q-FLG-5	N/A	N/A	SMAP retrieval quality flag	Can convert to a 16-bit binary to retrieve the individual flag values1. Refer to Table 3	SMAP
SM-6	m^3/m^3	0-0.6	SMAP soil moisture	Refer to Table 3	SMAP
Q-FLG-6	N/A	N/A	SMAP retrieval quality flag	Can convert to a 16-bit binary to retrieve the individual flag values1. Refer to Table 3	SMAP
SM-7	m^3/m^3	0-0.6	SMAP soil moisture	N/A	SMAP
Q-FLG-7	N/A	N/A	SMAP retrieval quality flag	Can convert to a 16-bit binary to retrieve the individual flag values1. Refer to Table 3	SMAP
ORB	N/A	N/A	Orbit number	Values are either ascending (positive) or descending (negative) orbits	N/A
[1] Users should only consider the defined bits when interpreting data flags, not the entire 16 bit integer					

Table 3 provides descriptions of the SMAP soil moisture and quality data fields for each of the SMAP match-up products.

Table 3. SMAP Soil Moisture Data and Quality Fields

Data Fields	SPL2SMP/SPL2SMP_E (see User Guide for more info)	SPL2SMA (see User Guide for more info)	SPL2SMAP (see User Guide for more info)
SM-1	Soil moisture retrieval from optional algorithm 1 - SCA-H. Corresponds to *soil_moisture_option1* data field.	Soil moisture retrieval from the time series algorithm. Corresponds to *soil_moisture data* field.	Soil moisture retrieval from v-pol option1 algorithm – disaggregated/downscaled vertical polarization brightness temperature. Corresponds to *soil_moisture_v_option1* data field.
Q-FLG-1	Quality flag for optional algorithm 1, SCA-H.* Corresponds to *retrieval_qual_flag_option1* data field.	Quality flag for the soil moisture and freeze-thaw retrieval. Corresponds to *retrieval_qual_flag* data field.	Quality flag for the baseline soil moisture retrieval. Corresponds to *retrieval_qual_flag* data field.
SM-2	Soil moisture retrieval from optional algorithm 2 - SCA-V. Corresponds to *soil_moisture_option2* data field.	Soil moisture retrieval from normalized change. Corresponds to *soil_moisture_change_index* data field.	Soil moisture retrieval from v-pol option2 algorithm – disaggregated/ downscaled vertical polarization brightness temperature. Corresponds to *soil_moisture_v_option2* data field.
Q-FLG-2	Quality flag for baseline algorithm 2, SCA-V.* Corresponds to *retrieval_qual_flag_option2* data field.	Quality flag for the soil moisture and freeze-thaw retrieval. Corresponds to *retrieval_qual_flag_change_index* data field.	Quality flag for the soil moisture retrieval. Corresponds to *retrieval_qual_flag_option2* data field.
SM-3	Soil moisture retrieval from optional algorithm 3. This algorithm is referred to as DCA in all versions of SPL2SMP and SPL3SMP_E except for versions 6 and 3, respectively, in which the DCA was replaced by the MDCA algorithm. For all versions of these products, this field corresponds to *soil_moisture_option3* data field.	Soil moisture retrieval from the Kim/van Zyl time series algorithm. Corresponds to *soil_moisture_kvz* data field.	Soil moisture retrieval from v-pol option 3 algorithm – disaggregated/downscaled vertical polarization brightness temperature. Corresponds to *soil_moisture_v_option3* data field.
Q-FLG-3	Quality flag for optional algorithm 3, DCA or MDCA.* Corresponds to *retrieval_qual_flag_option3* data field.	Quality flag for the soil moisture and freeze-thaw retrieval. Corresponds to the *retrieval_qual_flag_kvz* data field.	Quality flag for the baseline soil moisture retrieval. Corresponds to *retrieval_qual_flag* data field.
SM-4	Soil moisture retrieval from optional algorithm 4 - MPRA. Corresponds to *soil_moisture_option4* data field. Note: the MPRA algorithm was retired with the launch of SPL2SMP Version 6 and SPL2SMP_E Version 3; this field is no longer used.	Soil moisture retrieval from the Shi snapshot algorithm. Corresponds to *soil_moisture_snapshot_shi* data field.	Soil moisture retrieval from h-pol option1 – disaggregated/downscaled horizontal polarization brightness temperature. Corresponds to *soil_moisture_h_option1* data field.

Data Fields	SPL2SMP/SPL2SMP_E (see User Guide for more info)	SPL2SMA (see User Guide for more info)	SPL2SMAP (see User Guide for more info)
Q-FLG-4	Quality flag for optional algorithm 4, MPRA.* Corresponds to *retrieval_qual_flag_option4* data field. Note: the MPRA algorithm was retired with the launch of SPL2SMP Version 6 and SPL2SMP_E Version 3; this field is no longer used.	Quality flag for soil moisture and freeze-thaw retrieval. Corresponds to *retrieval_qual_flag* data value.	Quality flag for the baseline soil moisture retrieval. Corresponds to *retrieval_qual_flag* data field.
SM-5	Soil moisture retrieval from optional algorithm 5 - E-DCA. Corresponds to *soil_moisture_option5* data field. Note: the E-DCA algorithm was retired with the launch of SPL2SMP Version 6 and SPL2SMP_E Version 3; this field is no longer used.	Soil moisture retrieval from the snapshot algorithm. Corresponds to *soil_moisture_snapshot* data field.	Soil moisture retrieval from h-pol option2 – disaggregated/downscaled horizontal polarization brightness temperature. Corresponds to *soil_moisture_h_option2* data field.
Q-FLG-5	Quality flag for optional algorithm 5, E-DCA.* Corresponds to *retrieval_qual_flag_option5* data field. Note: the E-DCA algorithm was retired with the launch of SPL2SMP Version 6 and SPL2SMP_E Version 3; this field is no longer used.	Quality flag for soil moisture and freeze-thaw retrieval. Corresponds to *retrieval_qual_flag* data field.	Quality flag for soil moisture retrieval. Corresponds to *retrieval_qual_flag_option2* data field.
SM-6	N/A	Soil moisture retrieval from the Dubois/van Zyl snapshot algorithm. Corresponds to *soil_moisture_snapshot_DVZ* data field.	Soil moisture retrieval from h-pol option3 soil moisture – disaggregated/ downscaled horizontal polarization brightness temperature. Corresponds to *soil_moisture_h_option3* data field.
Q-FLG-6	N/A	Quality flag for soil moisture and freeze-thaw retrieval. Corresponds to *retrieval_qual_flag* data field.	Quality flag for the baseline soil moisture retrieval. Corresponds to *retrieval_qual_flag* data field.
SM-7	N/A	Soil moisture retrieval from the time series algorithm. Corresponds to *soil_moisture_time_series* data field.	N/A
Q-FLG-7	N/A	Quality flag for soil moisture and freeze-thaw retrieval. Corresponds to *retrieval_qual_flag* data field.	N/A

* Provided as a numerical value; can convert to a 16-bit binary to retrieve the individual flag values

1.2.3 Naming Convention

Files are named according to the following convention and as described in Table 4:

`NSIDC-0712_[Pixel ID]_SMAPL2SM[XXX]_[X]LVvvv_YYYYMMDD_yyyymmdd.[.ext]`

Table 4. File Name Description

Variable	Description
`NSIDC-0712`	Data Set ID
`[Pixel ID]`	Pixel ID is an 8-digit number composed by: Site ID (4 digits) + Core Site Grid Scale (2 digits) + Pixel Number (2 digits) See Table 5 for reference.
`SMAPL2SM[XXX]`	Associated SMAP product: `SMAPL2SMP`: SMAP L2 Passive `SMAPL2SMPE`: SMAP L2 Passive Enhanced `SMAPL2SMA`: SMAP L2 Active `SMAPL2SMAP`: SMAP L2 Active/Passive
`[X]LVvvv`	CRID of SMAP match-up product: a 5-digit ID usually preceded by R, T, or D, which indicates processing changes (i.e. algorithm or software) across products. `[X]`: R, T, or D `L`: Launch indicator (1: post-launch standard data) `V`: 1-digit major CRID version number `vvv`: 3-digit minor CRID version number Refer to Table 1 for CRID/version information.
`YYYYMMDD`	Start date (4-digit year, 2-digit month, 2-digit day)
`YYYYMMDD`	End date (4-digit year, 2-digit month, 2-digit day)
`.ext`	File extension: ASCII (`.txt`) or Metadata XML (`.MET.xml`)

As an example, the file `NSIDC-0712_03013602_SMAPL2SMP_T12323_20150401_20160229.txt` contains data from Site ID 0301 (core site REMEDHUS, as verified in Table 5) at the 36 km grid scale. These data can be used to validate the SMAP Level-2 Passive product. T12323 is the CRID for this match-up product which covers the period between 01 April 2015 and 29 February 2016.

1.3 Spatial Information

1.3.1 Coverage

Spatial coverage for the SMAP data is global (N: 85.044, S: -85.044, E: 180, W: -180). Coverage for the *in-situ* data varies based on the location of core sites, which are dispersed globally. The

SMAP Cal/Val Partners website contains a list of the various core sites, their geographical coordinates, and other relevant descriptors. Table 5 contains additional details.

1.3.2 Resolution

Spatial resolution for the *in-situ* data is the same as the match-up SMAP data: 3, 9, and 36 km.

1.4 Temporal Information

1.4.1 Coverage

Approximate start and end dates for the match-up SMAP data are listed below. Note that not all files start or end on those exact dates.

- SMAP L2 Radiometer Half-Orbit 36 km EASE-Grid Soil Moisture (SPL2SMP) — 01 April 2015 to 01 June 2019
- SMAP L2 Radar Half-Orbit 3 km EASE-Grid Soil Moisture (SPL2SMA) — 13 April 2015 to 08 July 2015
- SMAP L2 Radar/Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture (SPL2SMAP) — 14 April 2015 to 06 July 2015
- SMAP Enhanced L2 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture (SPL2SMP_E) — 01 April 2015 to 31 March 2021
- SMAP/Sentinel-1 L2 Radiometer/Radar 30-Second Scene 3 km EASE-Grid Soil Moisture (SPL2SMAP_S) – 01 April 2015 to 31 March 2021

1.4.2 Resolution

Temporal resolution varies due to the coincidence of the in situ and SMAP data.

Table 5. Core Validation Sites

Site ID	Site Name	Site PI	Location	Latitude, Longitude [I]	Core Site Grid Scales [km][II]	Climate Regime[III]	IGBP[IV] Land Cover	References
0201	TERENO	C. Montzka	Germany	50.5° N, 6.33° E	(Not a core site)	Temperate	Forest mixed	Zacharias et al., 2011
0301	REMEDHUS*	J. Martínez-Fernández	Spain	41.3° N, 5.4° W	9, 36	Temperate	Croplands	Martinez-Fernandez and Ceballos, 2005
0401	Reynolds Creek*	M. Seyfried	USA (Idaho)	43.188° N, 116.748° W	9, 36	Arid	Grasslands	Seyfried et al., 2001
0501	Kuwait	H. Jassar	Kuwait	29.3° N, 47.33° E	(Not a core site)	Temperate	Barren/sparse	(Not available)
0601	HOAL	M. Vreugdenhil/ W. Dorigo	Austria	48.2° N, 15.07° E	(Not a core site)	Temperate	Mixed forest	Blöschl et al., 2016
0701	Yanco*	J. Walker	Australia	34.8° S, 146.11° E	3, 9, 36	Semi-Arid	Croplands/ Grasslands	Panciera et al., 2014
0702	Kyeamba*	J. Walker	Australia	35.35° S, 147.52° E	3, 9, 36	Temperate	Grasslands	Smith et al., 2012
0901	Carman*	H. McNairn	Canada	49.62° N, 97.98° W	9, 36	Cold	Croplands	McNairn et al., 2015
0902	Casselman*	H. McNairn	Canada	45.47° N, 74.73° W	9	Cold	Croplands	(Not available)
1201	Naqu	Z. Su	Tibet	31.37° N, 91.88° E	(Not a core site)	Polar	Grasslands	Su et al., 2011; Su et al., 2013
1202	Maqu	Z. Su	Tibet	33.88° N, 102.13° E	(Not a core site)	Cold	Grasslands	Su et al., 2011; Su et al., 2013
1203	Ngari	Z. Su	Tibet	32.5° N, 79.97° E	(Not a core site)	Arid	Barren/sparse	Su et al., 2011; Su et al., 2013
1204	Twente*	Z. Su	The Netherlands	52.27° N, 6.67° E	36	Temperate	Cropland/natural mosaic	Dente et al., 2012

Site ID	Site Name	Site PI	Location	Latitude, Longitude [I]	Core Site Grid Scales [km][II]	Climate Regime[III]	IGBP[IV] Land Cover	References
1601	Walnut Gulch*	D. C. Goodrich/ C. Collins	USA (Arizona)	31.749° N, 110.026° W	3, 9, 36	Arid	Shrub open	Keefer et al., 2008
1602	Little Washita*	P. J. Starks	USA (Oklahoma)	34.97° N, 97.97° W	9, 36	Temperate	Grasslands	Cosh et al., 2006
1603	Fort Cobb*	P. J. Starks	USA (Oklahoma)	35.36° N, 98.55° W	36	Temperate	Grasslands	(Not available)
1604	Little River*	D. Bosch	USA (Georgia)	31.64° N, 83.65° W	3, 9, 36	Temperate	Cropland/ natural mosaic	Bosch et al., 2007
1606	St. Josephs*	S. Livingston	USA (Indiana)	41.449° N, 85.011° W	9	Cold	Croplands	(Not available)
1607	South Fork*	M. H. Cosh/ J. Prueger	USA (Iowa)	42.44° N, 93.44° W	3, 9, 36	Cold	Croplands	Coopersmith et al., 2015
1701	Sodankyla	J. Pulliainen	Finland	67.37° N, 26.65° E	(Not a core site)	Cold	Savannas woody	Rautiainen et al., 2012; Ikonen et al., 2016
1702	Saariselka	J. Pulliainen	Finland	67.97° N, 24.12° E	(Not a core site)	Cold	Savannas woody	(Not available)
1901	Bell Ville	M. Thibeault	Argentina	32.54° S, 62.61° W	36	Arid	Croplands	(Not available)
1902	Monte Buey*	M. Thibeault	Argentina	32.96° S, 62.52° W	3, 9, 36	Arid	Croplands	(Not available)
2401	Mpala	K. Caylor	Kenya	0.49° N, 36.87° E	(Not a core site)	Temperate	Grasslands	(Not available)
2501	Tonzi Ranch	M. Moghaddam	USA (California)	38.43° N, 120.97° W	(Not a core site)	Temperate	Savannas woody	Clewley et al., 2017
2601	Millbrook	M. Temimi	USA (New York)	41.78° N, 73.73° W	(Not a core site)	Cold	Forest deciduous broadleaf	(Not available)
2701	Kenaston*	A. Berg	Canada	50.45° N, 106.38° W	3, 9, 36	Cold	Croplands	Rowlandson et al,. 2015

Site ID	Site Name	Site PI	Location	Latitude, Longitude [I]	Core Site Grid Scales [km][II]	Climate Regime[III]	IGBP[IV] Land Cover	References
3201	Tabasco	J. Ramos	Mexico	17.93° N, 92.84° W	(Not a core site)	Tropical	Croplands	(Not available)
4101	Valencia*	E. Lopez-Baeza	Spain	39.57° N, 1.29° W	3, 9	Arid	Savannas woody	(Not available)
4401	EURAC	C. Notarnicola	Italy	46.68° N, 10.59° E	(Not a core site)	Polar	Shrub open	Pasolli et al., 2015
4501	Niger	B. Cappelaere/ T. Pellarin	Niger	13.575° N, 2.663° E	(Not a core site)	Arid	Grasslands	Louvet et al., 2015
4502	Benin	S. Galle/ T. Pellarin	Benin	9.789° N, 1.679° E	(Not a core site)	Arid	Savannas	Louvet et al., 2015
4801	TxSON**	T. Caldwell	USA (Texas)	30.5° N, 98.5° W	3, 9, 36	Temperate	Grasslands	(Not available)
5301	Mongolian grasslands**	J. Asanuma	Mongolia	46.063° N, 106.774° E	36	Cold	Grasslands	Wen et al., 2014
6701	HOBE	K. H. Jensen	Denmark	55.97° N, 9.10° E	36	Temperate	Croplands	Bircher et al., 2012

* Core site status at launch

** Core site status acquired after launch

[I] geographical coordinates given in WGS 84

[II] (Not a core site) = currently not a core site at any scale (3, 9, or 36 km), but this may change in the future

[III] Koeppen-Geiger climate classification (Peel et al., 2007)

[IV] International Geosphere-Biosphere Programme (IGBP)

2 DATA ACQUISITION AND PROCESSING

2.1 Background

In an effort to ensure the geographic distribution and diversity of conditions of the Core Validation Sites (CVS), SMAP partnered with investigators around the globe. These Calibration/Validation (Cal/Val) partners play a crucial role in the execution of the SMAP Cal/Val Plan (Jackson et al., 2013). CVS candidates were selected based on a minimum requirement of continuous soil moisture measurements at 5 cm depth; the measurements also needed to be replicated within a grid cell of at least one of the SMAP spatial scales (although some sites have multiple pixels at 9 km and 3 km scale). Table 5 lists the site candidates. The sites are divided into two categories: (a) those where confidence in their representativeness of a site at a certain spatial scale is high enough for using the site as a basis of computing the performance metrics (the elected core sites), and (b) sites that can be utilized for algorithm testing but the confidence that they are representative is not high enough for using the site in the metrics computations (the non-core sites).

Criteria for determining whether a site is a CVS include:

- Number of sensors within the pixel
- Geographical distribution of sensors within the pixel
- Calibration of the soil moisture sensors
- Quality assessment of the measured soil moisture time-series
- Spatial up-scaling function
- Maturity as a large-scale reference

Sites that initially did not meet these requirements have the option of performing supplemental investigations such as additional field sampling and modeling studies to eventually reach CVS status. Because different SMAP surface soil moisture products have different spatial scales, the suitability of the various sites for validation of the different products must be evaluated separately. Currently qualified core validation sites represent land cover types that together extend over about 70% of the retrieval domain defined for the products. Upgrading some of the current candidate sites to CVS status would raise this figure close to 100% (Colliander et al., 2017).

2.2 Acquisition

The SMAP soil moisture data products in this data set are:

- SMAP L2 Radiometer Half-Orbit 36 km EASE-Grid Soil Moisture, Versions 3–6 (SPL2SMP)

- SMAP L2 Radar/Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture, Version 3, (SPL2SMA)
- SMAP L2 Radar Half-Orbit 3 km EASE-Grid Soil Moisture Version 3 (SPL2SMAP)
- SMAP Enhanced L2 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture, Versions 1–4 (SPL2SMP_E)

Information regarding SMAP data versions and CRIDs are provided in Table 1.

For information regarding algorithms and product specifications, refer to the Assessment Reports provided in Table 1.

2.3 Processing

As shown in **Figure 1**, in situ data provided by the Cal/Val partners goes through several processing steps before being matched with corresponding SMAP products.

- The *in-situ* data are run through an automatic Quality Control (QC) procedure before determining the up-scaled soil moisture values for each pixel. The QC is implemented largely following the approach presented in Dorigo et al., 2012. The *in-situ* data are checked for various issues, including missing data, out of range values, spikes, sudden drops and physical temperature limits.
    - Additionally, since some sensors begin to exhibit unpredictable behavior below 4°C, the physical temperature is checked.
    - Finally, some stations are excluded because they do not represent the surrounding environment. As an example, this exclusion may be based on irrigation activities or the location of the station.
- Next, the up-scaling function is applied to the data. The up-scaling function is developed using the set of sensors that function properly for the majority of the time period under consideration. This means that the Voronoi diagrams are determined with only functioning sensors, and the sensors that fail during the time period are left outside the process entirely.
- Coincident overpasses of SMAP data in time and space are then matched with the up-scaled in situ timeseries that are closest to the overpass time.

The high level of automation in this process allows tracking the performance of the soil moisture products periodically and with low latency because repetitive, manual involvement is minimized. Match-up products are then used for validation and further development of SMAP algorithms.

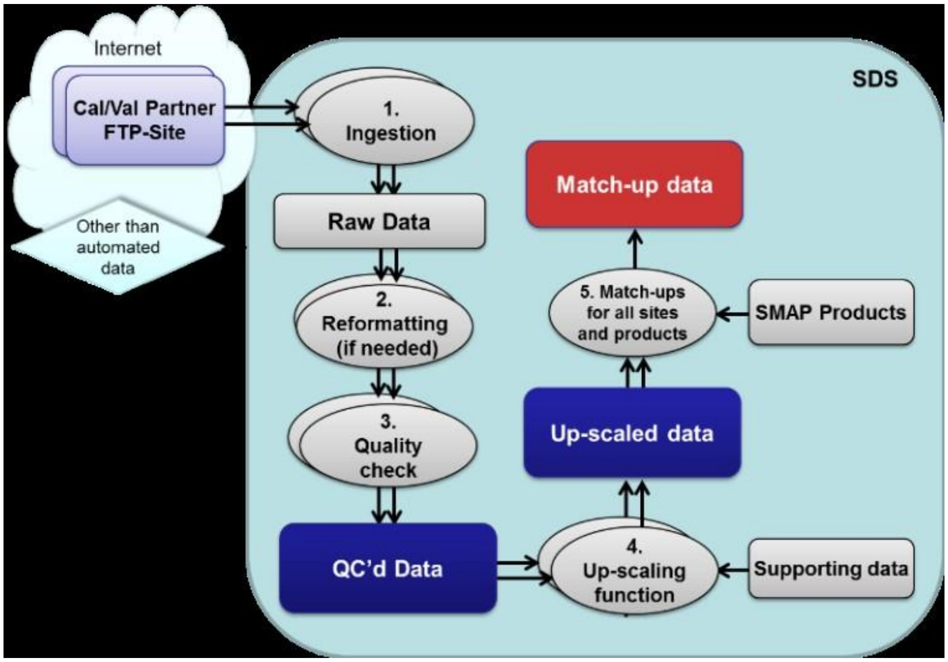

Figure 1. Processing Steps

2.4 Quality, Errors, and Limitations

Error sources and data quality are discussed in Jackson et al., 2016, Chan et al., 2016, and Colliander et al., 2017. SMAP retrieval algorithm uncertainties are discussed in the corresponding ATBD (O'Neill et al., 2015).

2.5 Instrumentation

For a detailed description of the SMAP instrument, visit the SMAP Instrument page at the JPL SMAP Web site. For the *in-situ* data, investigators used various soil moisture and soil temperature probes.

3 RELATED DATA SETS

SMAP Data at NSIDC | Overview

SMAP Enhanced L2 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture

SMAP L2 Radiometer Half-Orbit 36 km EASE-Grid Soil Moisture

SMAP L2 Radar Half-Orbit 3 km EASE-Grid Soil Moisture

SMAP L2 Radar/Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture

4 RELATED WEBSITES

SMAP at NASA JPL

5 CONTACTS AND ACKNOWLEDGMENTS

Special Instructions: Please use Table 5 to identify the appropriate contact based on the name listed under Site PI or visit the JPL CAL/VAL Partners website.

5.1 Data Authors and Contacts

Andreas Colliander

Jun Asanuma

Aaron Berg

Tara Bongiovanni

David Bosch

Todd Caldwell

Michael Cosh

Chandra Holified-Collins

Karsten Jensen

Stan Livingston

Ernesto Lopez-Baeza

Jose Martinez-Fernandez

Heather McNairn

John Prueger

Mark Seyfried

Patrick Starks

Zhongbo Su

Marc Thibeault

Jeffrey Walker

5.2 Partners and Acknowledgements

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Andreas Colliander, Jet Propulsion Laboratory
Jun Asanuma, Tsukuba University
Aaron Berg, University of Guelph
Tara Bongiovanni, University of Texas Austin
David D. Bosch, USDA ARS Southeast Watershed Research
Jose Martinez-Fernandez, University of Salamanca
Todd Caldwell, United States Geological Survey
Kelly Caylor, Princeton University
Chandra Holifield Collins, USDA ARS Southwest Watershed Research Michael Cosh, USDA Agriculture Research Service
Wouter Dorigo, Technical University of Wien

Karsten Hala Al Jassar, Kuwait University
Jensen, University of Copenhagen
Stanley Livingston, USDA ARS National Soil Erosion Research Lab
Ernesto Lopez-Baeza, University of Valencia
Heather McNairn, Agriculture and Agri-food Canada
Mahta Moghaddam, University of Southern California
Carsten Montzka, Research Center Julich
Claudia Notarnicola, European Academy of Bozen
Thierry Pellarin, University Joseph Fourier
John Prueger, USDA ARS National Laboratory for Agriculture and the Environment
Jouni Pulliainen, Finnish Meteorological Institute
Judith Ramos Hernandez, National Autonomous University of Mexico
Mark Seyfried, USDA Agriculture Research Service
Patrick J. Starks, USDA ARS Grazinglands Research Laboratory
Zhongbo Su, University of Twente
Marouane Temimi, City College of New York
Marc Thibeault, CONAE
Jeffrey Walker, Monash University
Mehrez Zribi, CNES

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7 TECHNICAL REFERENCES

For additional references, see the SMAP Technical References page.

8 DOCUMENT INFORMATION

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