



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:

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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 $^{\circ}\text{C}$.

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

| Subdirectory | 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 |
|--------------|-----------------|--|-----------|--|---|---------------------------------|
| 2015.04.01 | SPL2SMP | SMAPL2SMP | Version 3 | T12323 | R13080 | Report |
| 2015.04.01 | SPL2SMP | SMAPL2SMP | Version 4 | R13080 | R14010, R15060, R15152, R15180, R15181, R15182 | Report |
| 2015.04.01 | SPL2SMP | SMAPL2SMP | Version 5 | T15600 | R16000, R16010 | Report |
| 2015.04.01 | SPL2SMP | SMAPL2SMP | Version 6 | T16500 | R16510 | Report |
| 2015.04.01 | SPL2SMP_E | SMAPL2SMPE | Version 1 | D14000 | R14010, R15060, R15152, R15180, R15181, R15182 | Report |
| 2015.04.01 | SPL2SMP_E | SMAPL2SMPE | Version 2 | R16010 | R16000, R16010 | Report |
| 2015.04.01 | SPL2SMP_E | SMAPL2SMPE | Version 3 | R16510 | R16510 | Report |
| 2015.04.01 | SPL2SMP_E | SMAPL2SMPE | Version 4 | T16700 | R17000 | Report |
| 2015.04.13 | SPL2SMA | SMAPL2SMA | Version 3 | T12400 | R13080 | Report |
| 2015.04.13 | SPL2SMAP | SMAPL2SMAP | Version 3 | D12000 | R13080 | 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 | <i>In-situ</i> |
| 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 | <i>In-situ</i> |
| 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) | <i>In-situ</i> |
| AST | °C | 0-50 | Average Soil Temperature of reference pixel | Obtained from the sensors deployed within the SMAP reference pixel area | <i>In-situ</i> |
| 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 values ¹ . 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 values ¹ . 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 values ¹ . 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 values ¹ . 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 values ¹ . 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 values ¹ . 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 values ¹ . 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 values ¹ . 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 <i>soil_moisture_option1</i> data field. | Soil moisture retrieval from the time series algorithm. Corresponds to <i>soil_moisture_data</i> data field. | Soil moisture retrieval from v-pol option1 algorithm – disaggregated/downscaled vertical polarization brightness temperature. Corresponds to <i>soil_moisture_v_option1</i> data field. |
| Q-FLG-1 | Quality flag for optional algorithm 1, SCA-H.* Corresponds to <i>retrieval_qual_flag_option1</i> data field. | Quality flag for the soil moisture and freeze-thaw retrieval. Corresponds to <i>retrieval_qual_flag</i> data field. | Quality flag for the baseline soil moisture retrieval. Corresponds to <i>retrieval_qual_flag</i> data field. |
| SM-2 | Soil moisture retrieval from optional algorithm 2 - SCA-V. Corresponds to <i>soil_moisture_option2</i> data field. | Soil moisture retrieval from normalized change. Corresponds to <i>soil_moisture_change_index</i> data field. | Soil moisture retrieval from v-pol option2 algorithm – disaggregated/ downscaled vertical polarization brightness temperature. Corresponds to <i>soil_moisture_v_option2</i> data field. |
| Q-FLG-2 | Quality flag for baseline algorithm 2, SCA-V.* Corresponds to <i>retrieval_qual_flag_option2</i> data field. | Quality flag for the soil moisture and freeze-thaw retrieval. Corresponds to <i>retrieval_qual_flag_change_index</i> data field. | Quality flag for the soil moisture retrieval. Corresponds to <i>retrieval_qual_flag_option2</i> 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 <i>soil_moisture_option3</i> data field. | Soil moisture retrieval from the Kim/van Zyl time series algorithm. Corresponds to <i>soil_moisture_kvz</i> data field. | Soil moisture retrieval from v-pol option 3 algorithm – disaggregated/downscaled vertical polarization brightness temperature. Corresponds to <i>soil_moisture_v_option3</i> data field. |
| Q-FLG-3 | Quality flag for optional algorithm 3, DCA or MDCA.* Corresponds to <i>retrieval_qual_flag_option3</i> data field. | Quality flag for the soil moisture and freeze-thaw retrieval. Corresponds to the <i>retrieval_qual_flag_kvz</i> data field. | Quality flag for the baseline soil moisture retrieval. Corresponds to <i>retrieval_qual_flag</i> data field. |
| SM-4 | Soil moisture retrieval from optional algorithm 4 - MPRA. Corresponds to <i>soil_moisture_option4</i> 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 <i>soil_moisture_snapshot_shi</i> data field. | Soil moisture retrieval from h-pol option1 – disaggregated/downscaled horizontal polarization brightness temperature. Corresponds to <i>soil_moisture_h_option1</i> 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 <i>retrieval_qual_flag_option4</i> 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 <i>retrieval_qual_flag</i> data value. | Quality flag for the baseline soil moisture retrieval. Corresponds to <i>retrieval_qual_flag</i> data field. |
| SM-5 | Soil moisture retrieval from optional algorithm 5 - E-DCA. Corresponds to <i>soil_moisture_option5</i> 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 <i>soil_moisture_snapshot</i> data field. | Soil moisture retrieval from h-pol option2 – disaggregated/downscaled horizontal polarization brightness temperature. Corresponds to <i>soil_moisture_h_option2</i> data field. |
| Q-FLG-5 | Quality flag for optional algorithm 5, E-DCA.* Corresponds to <i>retrieval_qual_flag_option5</i> 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 <i>retrieval_qual_flag</i> data field. | Quality flag for soil moisture retrieval. Corresponds to <i>retrieval_qual_flag_option2</i> data field. |
| SM-6 | N/A | Soil moisture retrieval from the Dubois/van Zyl snapshot algorithm. Corresponds to <i>soil_moisture_snapshot_DVZ</i> data field. | Soil moisture retrieval from h-pol option3 soil moisture – disaggregated/ downscaled horizontal polarization brightness temperature. Corresponds to <i>soil_moisture_h_option3</i> data field. |
| Q-FLG-6 | N/A | Quality flag for soil moisture and freeze-thaw retrieval. Corresponds to <i>retrieval_qual_flag</i> data field. | Quality flag for the baseline soil moisture retrieval. Corresponds to <i>retrieval_qual_flag</i> data field. |
| SM-7 | N/A | Soil moisture retrieval from the time series algorithm. Corresponds to <i>soil_moisture_time_series</i> data field. | N/A |
| Q-FLG-7 | N/A | Quality flag for soil moisture and freeze-thaw retrieval. Corresponds to <i>retrieval_qual_flag</i> 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 2020

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.

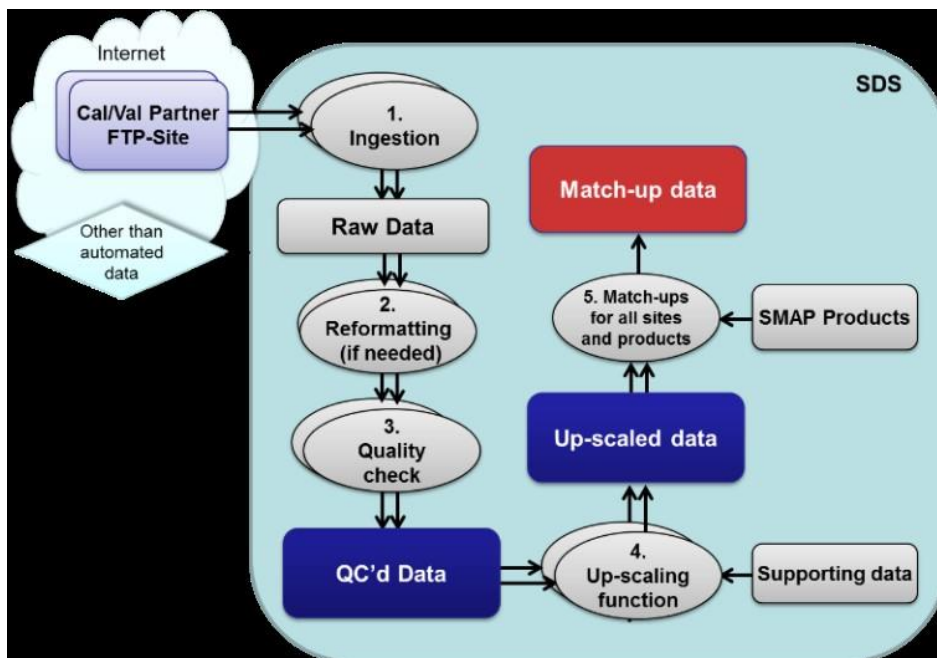


Figure 1. Processing Steps

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.

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7 TECHNICAL REFERENCES

For additional references, see the SMAP [Technical References](#) page.

8 DOCUMENT INFORMATION

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