scirocco

scatterometer instrument competence centre

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1 Introduction

The Product User Manual (PUM) summarizes the product lineage and format of the ERS ESCAT surface soil moisture orbit product. A general introduction of the purpose of the document followed by an overview of the surface soil moisture products concerned by this document are described. An extensive description of the ESCAT instrument and Level 1 product processing is outlined in Section 2. The product description is discussed in section 3, followed by information about product the validation (see Section 4) and the product availability in Section 5. References to technical reports and journal articles are summarized at the end of the document in Section 6.

In the framework of the SCIRoCCo project several soil moisture products, with different spatial resolution, format (e.g. time series, swath orbit geometry) are generated and distributed to users. A list of available soil moisture products, as well as other SCIRoCCo products (such as wind vector fields) can be looked up on the SCIRoCCo website [http://scirocco.sp.serco.eu/]. The following Table 1.1 gives an overview of the instances of soil moisture products related to this PUM.

ID	Product Name
ERS2-ASPS-N-SSM-Or	ERS-2 ESCAT nominal resolution SSM orbits (12.5 km sampling)
ERS2-ASPS-H-SSM-Or	ERS-2 ESCAT high resolution SSM orbits (12.5 km sampling)

Table 1.1: List of soil moisture products related to this PUM.

1.1 Scope

The Product User Manual (PUM) is intended to provide a detailed description of the main product characteristics, format, validation activities and availability.

The PUM contains:

- Product introduction: principle of sensing, satellites utilized, instrument(s) description, highlights of the algorithm, architecture of the products generation chain, product coverage and appearance
- Main product characteristics: Spatial resolution and sampling, observing cycle and time sampling
- Overview of the product validation activity: validation strategy, global statistics, product characterization
- Basic information on product availability: access modes, description of the code, description of the file structure

Although reasonably self-standing, the PUM's rely on other documents for further details [RD-1, RD-2].

Targeted audience

his document mainly targets:

1. Remote sensing experts interested in soil moisture from active microwave data sets.
2. Users of the remotely sensed soil moisture data sets.

1.2 Applicable and Reference Documents

Applicable Documents

The following documents are related to this document:

ID	Reference	Document Title	Issue	Date
AD-1	ERSE-GSEV-EOPG-RS-06-0002[1]	ASPS Product Format	2	08/04/09
AD-2				
AD-3				

Reference Documents

The following documents provide further reference information:

ID	Reference	Document Title	Issue	Date
RD-1	SCI-TNO-16-0044-v02	Algorithm Theoretical Baseline Document (ATBD)	v0.2	-
RD-2	SCI-RPT-16-0046-v02	Product Validation Report (PVR)	v0.2	-

[1] https://earth.esa.int/c/document_library/get_file?folderId=13019&name=DLFE-610.pdf

		unit	ERS-1	ERS-2
Repeat cycle		[orbits]	43 501 2411	501
		[days]	3 35 168	35
Orbits/day		-	14.333 14.314 14.351	14.314
Ground velocity		[km/s]	7	
LMT at ascending node		-	22:15	22:30
Spacecraft mass		[kg]	2384	2516
SCAT payload mass		[kg]	1100	

Table 2.1: ERS-1/2 mission parameter overview.

2 ESCAT on-board the European Remote Sensing Satellites

On 17 July 1991, ESA launched the first European Remote Sensing (ERS) satellite from the Kourou launch site in French Guiana [Vass et al., 1992]. ERS-1 was the major forerunner of the present European satellites for environmental monitoring, with development and predecessor studies dating back to the early seventies [ESA, 2013]. The ERS-1 payload carried an array of instruments for environmental monitoring of land, water, ice and atmosphere. The centrepiece of the ERS-1 payload was the Active Microwave Instrument (AMI), combining the functionality of a Synthetic Aperture Radar (SAR) and a wind scatterometer (ESCAT). Other instruments on-board were a Radar Altimeter, an Along-Track Scanning Radiometer, a Precise Range and Range-Rate equipment and a Laser Retro-Reflector. The system was designed for a nominal lifetime of 3 years, but it was not until March 2000, that ERS-1 mission ended after 9 years of excellent service due to a failure in the on-board attitude control system. Already on 21 April 1995 the follow-on mission ERS-2 was launched, equipped with an almost identical payload as ERS-1, but with an additional sensor on-board for atmospheric ozone research. In July 2011, after 16 years in space, ERS-2 was decommissioned and removed from its operational orbit, comprising, together with ERS-1, a scatterometer data archive of 20 years of Earth backscatter measurements. Both satellites were brought into an elliptical sun-synchronous orbit at approximately 785 km altitude and 98.5° inclination. Consequently, the nominal orbit period was approximately 100 minutes, with an ascending node (crossing of the Equator northwards) time of 22:15 local mean time (LMT) for ERS-1 and of 22:30 LMT for ERS-2 respectively. A standard orbit repeat cycle of 35 days was appointed for both satellites, supplemented with two additional repeat cycles of 3 and 168 days specifically dedicated to ERS-1. An overview of mission relevant parameters is given in Table 2.1.

2.1 Functional Description

As already mentioned, the Active Microwave Instrument (AMI) was the center-piece of the ERS payload. It was designed as a multi-mode RADAR, operating at a frequency of 5.3 GHz (C-band), by combining the functionality of a high resolution SAR and a low resolution wind scatterometer (ESCAT) [Attema, 1991]. AMI SAR operations were performed in two distinct modes: image and wave. In wind mode, AMI was configured as a wind scatterometer to provide backscatter measurements of the Earth's surface. The image and wind mode were mutually exclusive due to the high power consumption and data rate required for high resolution SAR image acquisition. Nevertheless, AMI could operate in a wind/wave mode, in which wind and wave mode were operated sequentially, enabling simultaneous characterization of the wind and wave fields over the oceans. Measurements in wind mode were acquired with three sideways looking, vertically polarized (VV) fan-beam antennas, one looking perpendicular to the right with respect to the satellite track (mid-beam), one looking forward at 45° angle (fore-beam) and one looking backward at 135° angle (aft-beam) illuminating a 500 km wide swath (see Figure 2.1). The transmitter unit of the scatterometer generated a rectangular radio frequency pulse with a duration of 130 μs for the fore- and aft-beam and of 70 μs for the mid-beam antenna. The three antennas were operated in sequences of 32 radio frequency pulses each, starting with the Fore-beam antenna. The pulse repetition frequency was chosen to be 98 Hz for the side antennas and 115 Hz for the mid antenna, resulting in a total repeat cycle length of 940.84 ms referred to as FMA sequence. Four FMA sequences last 3.763 s, which correspond to approximately 25 km along the ground track of the satellite. During each beam sequence of 32 pulses, 4 internal calibration pulses and 28 noise signals were measured [Lecomte, 1998]. The internal calibration pulse was a replica of the transmitted pulse fed into the receiver chain. The aim was to monitor the power of the transmitted pulse and the receiver gain to guarantee instrument stability during the mission, hence the term internal calibration. Noise measurements were necessary to account for thermal radiation superimposing the received echo signal to improve the signal-to-noise ratio. An analogue to digital converter (ADC) was used to sample the echo signal, the internal calibration pulses and the noise measurements at 30 kHz. A sampling of the received echo signal at 30 kHz corresponds to a across track resolution of approximately 32.4 km at 18° and 14 km at 45.5° incidence angle for the mid-beam.

	unit	ESCAT
Frequency	[GHz]	5.3
Wavelength	[cm]	5.66
Chirp rate	[kHz/ms]	-
Polarisation	-	VV
Peak Power Pulse	[W]	4800
Pulse Duration	[μs]	70 (mid) 130 (fore/aft)
PRF	[Hz]	115 (mid) 98 (fore/aft)
Incidence Angle	[deg]	18-47 (mid) 25-59 (fore/aft)
Antenna Angle	[deg]	45 (fore) 0 (mid) -45 (aft)
Swath width	[km]	500
Swath offset	[km]	200
Radiometric Res.	[%]	6.5 - 7.0

Table 2.2: Overview of ESCAT technical parameters.

2.2 Ground Processing

On-board tape recorders were used to store the sampled echo signals, the internal calibration pulses and the noise measurements after various on-board processing steps. These data packages were down-linked to ground stations for further on-ground processing, along with external data (orbit and attitude information) and characteristics of the instrument, in order to achieve the required system performance. In a first step, the signal is processed to improve the signal-to-noise ratio and to correct for transmitter and receiver chain fluctuations (internal calibration). Subsequently, the power echo samples were converted to the normalized radar cross section, σ^0, by utilizing predetermined normalization factors. The normalization factors were defined as the power at the input equal to a uniform reference backscatter coefficient of unity on the Earth's surface. These normalisation factors are a function of changing geometry along the orbit for a given antenna provided as Look-Up-Tables. In a further processing step, a spatial filter was applied to the σ^0 samples to increase the radiometric resolution and achieve the desired point target response along a grid of nodes, representing the entire swath. Calculation of the position of each node in the swath was based on the Mid-beam antenna. The central node position of the swath was determined at the intersection of the Mid-beam bore-sight direction with the Earth's surface. From this central node, more nodes are computed at every 25 km arc distance towards the near and far edge of the swath, along a perpendicular oriented line with respect to the satellite ground track. This is repeated after 4 FMA sequences, corresponding to an along track node interval of 25 km. Once the node positions within the swath were determined, the σ^0 samples located within a certain area around a node were averaged in along and across-track direction using a so-called Hamming function for each antenna beam. The aim of this function is to apply weights to various σ^0 samples, according to their distance to the regarded node. Ultimately, each node in the swath holds a σ^0 value of each antenna beam referred to as σ^0-triplet. This processing step is of major importance, due to the fact that it impacts the characteristic of the σ^0 values and particularly the final spatial resolution of the product. A detailed discussion about the on-ground processing steps of ERS-1/2 ESCAT data packages can be found in Lecomte [1998] and Neyt et al. [2002].

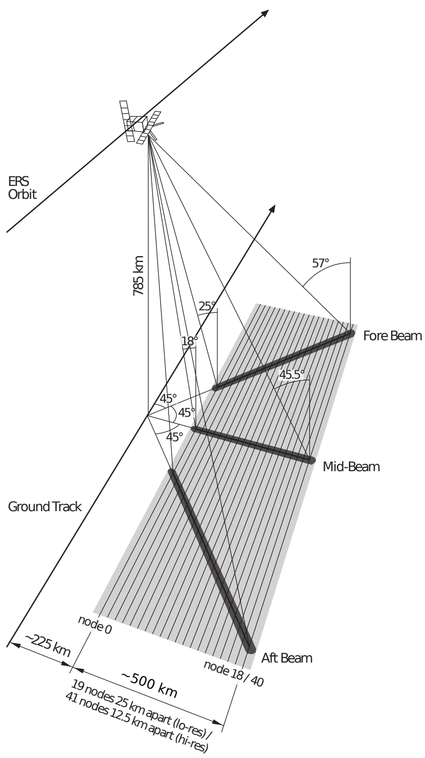

Figure 2.1: Instrument configuration and resulting orbit grid representation (swath) of ERS ESCAT adopted from Bartalis [2009].

3 Product description

Surface soil moisture records are derived from the backscatter coefficient σ° measured by the scatterometer (ESCAT) on-board the European Remote Sensing (ERS) satellites using the TU Wien soil moisture retrieval algorithm Naeimi et al. [2009]; Wagner et al. [1999]. In the TU Wien algorithm, long-term records of backscatter measurements are used to model the incidence angle dependency of backscatter, which allows a normalization to a common reference incidence angle ($\theta_r = 40$). The relative surface soil moisture estimates range between 0% and 100% and are derived by scaling the normalized backscatter between the lowest/highest backscatter values corresponding to the driest/wettest soil conditions. Soil moisture is represented in degree of saturation S_d, but can be translated from relative (%) to absolute volumetric units ($m^3 m^{-3}$) using porosity information (see **Eq. 3-1**).

The soil moisture retrieval algorithm is implemented in a software called the WAter Retrieval Package (WARP). ERS ESCAT Level 1b data sets with a spatial sampling of 12.5 km, high resolution, and 25 km, nominal resolution, are used to retrieve relative surface soil moisture information. Except surface temperature data, used for training a freeze-thaw detection algorithm, and a static climate classification map (used for the determination of the wet correction) no external data is required for the retrieval. A detailed description of the TU Wien soil moisture retrieval algorithm together with a description of the derivation of the model parameters can be found in the Algorithm Theoretical Baseline Document (ATBD) [RD-1].

In addition to WARP, a second software package, referred to as WARP orbit, was developed in response to the strong demand of soil moisture estimates in satellite orbit geometry. WARP orbit is a standalone and simplified implementation of the TU Wien soil moisture retrieval model operating in the orbit domain. WARP orbit relies on global model parameters estimated with WARP, although WARP and WARP orbit are independent in terms of their implementation. Model parameters derived from WARP serve as an input data stream for the WARP orbit processing chain as well as Level 1 scatterometer data. The main difference to WARP is that WARP orbit is capable to retrieve soil moisture values directly in orbit geometry. The following list shows the performed processing step sequence utilized in the WARP orbit processor with reference to the Algorithmic Theoretical Baseline Document [RD-1]:

1. Read grid information.
2. Read Level 1 orbit input file.
3. Read WARP soil moisture model parameters and interpolate to orbit grid.
4. Apply azimuthal correction to backscatter measurements [see RD-1]
5. Calculate normalized backscatter at $\theta_r = 40$ and its noise [see RD-1].
6. Calculate surface soil moisture (SSM) and surface state flag (SSF) and their corresponding noise values [see RD-1].

The Numerical Weather Predication (NWP) community has a major interest in orbit based soil moisture products because of the requirement of geophysical variable observation as "close" as possible to the satellite measurements. As a consequence, the decision was made to design the Level 2 processing architecture, WARP orbit, to meet the requirements of the NWP community by providing a soil moisture product in the appropriate format.

3.1 Parameters

The Level 2 soil moisture orbit product is composed of several parameters (geophysical parameters, flags, geo-location information, etc.). The following subsections will give an overview of all relevant Level 1 and Level 2 parameters and as well as additional flags included in the product.

Level 1 parameters

The Level 2 soil moisture orbit product contains a series of Level 1 data information relevant in the soil moisture retrieval algorithm. A detailed description of the included parameters can be found in the ASPS Product Format Specifications document [AD-1].

Name	Scaling factor	Units	Type	Byte size
AZI_ANGLE_AFT	10^2	%	uint16	2
AZI_ANGLE_FOR	10^2	%	uint16	2
AZI_ANGLE_MID	10^2	%	uint16	2
INC_ANGLE_AFT	10^2	%	uint16	2
INC_ANGLE_FOR	10^2	%	uint16	2
INC_ANGLE_MID	10^2	%	uint16	2
SIGMA0_AFT	10^2	%	uint16	2
SIGMA0_FOR	10^2	%	uint16	2
SIGMA0_MID	10^2	%	uint16	2

Table 3.1: Overview of Level 1 parameters.

Azimuth Angle for re-sampled backscatter coefficient σ^0 of each beam (`AZI_ANGLE_AFT`, `AZI_ANGLE_FOR`, `AZI_ANGLE_MID`)

Incidence Angle for re-sampled backscatter coefficient σ^0 of each beam (`INC_ANGLE_AFT`, `INC_ANGLE_FOR`, `INC_ANGLE_MID`)

Backscatter Coefficient re-sampled on orbit grid of each beam (`SIGMA0_AFT`, `SIGMA0_FOR`, `SIGMA0_MID`)

Level 2 parameters

The Level 2 parameters represent new variables which have been derived from the respective Level 1b product. The following table summarizes these parameters.

Name	Scaling factor	Units	Type	Byte size
SOIL_MOISTURE	10^2	%	uint16	2
SOIL_MOISTURE_ERROR	10^2	%	uint16	2
MEAN_SURF_SOIL_MOISTURE	10^2	%	uint16	2
SIGMA40	10^6	dB	int32	4
SIGMA40_ERROR	10^6	dB	int32	4
SLOPE40	10^6	$\frac{dB}{deg}$	int32	4
SLOPE40_ERROR	10^6	$\frac{dB}{deg}$	int32	4
SOIL_MOISTURE_SENSITIVITY	10^6	dB	uint32	4
DRY_BACKSCATTER	10^6	dB	int32	4
WET_BACKSCATTER	10^6	dB	int32	4

Table 3.2: Overview of Level 2 parameters.

Surface soil moisture and its noise The surface soil moisture estimate (`SOIL_MOISTURE`) represents the topmost soil layer (< 5 cm) and is given in degree of saturation S_d, ranging from 0% (dry) to 100% (wet). S_d can be converted into (absolute) volumetric units m^3m^{-3} with the help of soil porosity information.

$$\Theta = p \cdot \frac{S_d}{100} \qquad \textbf{Eq. 3-1}$$

where Θ is absolute soil moisture in m^3m^{-3}, p is porosity in m^3m^{-3}. As it can be seen in **Eq. 3-1**, the accuracy of soil porosity is as much as important as the relative soil moisture content.

An estimate of the uncertainty is given in the soil moisture noise (`SOIL_MOISTURE_ERROR`) and its unit is degree of saturation in %.

Mean surface soil moisture The mean (`MEAN_SURF_SOIL_MOISTURE`) is derived from surface soil moisture time series based on ERS-2 scatterometer data of the period 01/1997–12/2002.

Normalized backscatter coefficients and its noise Backscatter is measured under various incidence angles. The normalized backscatter coefficient (`SIGMA40`) is equivalent to backscatter at a reference incidence angle of $\theta_r = 40$. The normalized backscatter is complemented by its noise (`SIGMA40_ERROR`), derived by error propagation of the backscatter noise (covering instrument noise, speckle and azimuthal effects).

Seasonal variation of slope and its noise The incidence angle dependency of the backscatter is largely determined by the amount of above ground biomass and by surface roughness. Mathematically it can be described by a second order polynomial determined by a slope and a curvature term. The slope term (`SLOPE`) is especially sensitive to vegetation growth and senescence. The slope is complemented by the its noise (`SLOPE_ERROR`), derived by error propagation of the backscatter noise (covering instrument noise, speckle and azimuthal effects).

Sensitivity, dry and wet backscatter reference The sensitivity (SOIL_MOISTURE_SENSITIVTY) to measure soil moisture is defined by the difference of the dry (DRY_BACKSCATTER) and wet (WET_BACKSCATTER) backscatter reference values. For a given point in time generally, the sensitivity depends on the amount of above ground biomass. High amounts of biomass result in a low sensitivities to soil moisture.

Geo-location and satellite parameters

The geo-location and satellite parameters

Name	Scaling factor	Units	Type	Byte size
coordinate_id	-	-	int64	8
lat	-	Degrees North	float32	4
lon	-	Degrees East	float32	4
time	-	Days since 1900-01-01 00:00:00 UTC	float64	8

Table 3.3: Overview of geo-location and satellite parameters.

Location ID The location id (location_id) is a unique identifier for a single grid point (GP) in the orbit grid defined by the instrument.

Latitude The latitude (lat) position of the GP in degrees north.

Longitude The longitude (lon) position of the GP in degrees east.

Time The time parameter (time) represents the time stamp for the measurements. It is defined as the days since 1900-01-01 00:00:00 UTC (e.g. 1900-01-01 00:00:00 UTC + 39081.2494791667 = 2007-01-01 05:59:15 UTC).

Processing and correction flags

These flags indicate several conditions of interest if a certain bit has been set. A bit is set when it has value 1 and not set when it has value 0.

Name	Scaling factor	Units	Type	Byte size
PROCESSING_FLAGS	-	-	uint8	1
CORRECTION_FLAGS	-	-	uint8	1

Table 3.4: Processing and correction field.

Processing flags Processing flags (PROCESSING_FLAGS) are set to flag the reason for a soil moisture value not being provided in the product.

- *Bit 1 set:* Not meaningful soil measurement since a) less than 3 valid neighbours in the parameter neighborhood for Hamming windowing exist or b) the number of invalid neighbours is larger than the number of valid neighbors.
- *Bit 2 set:* Sensitivity to soil moisture below the 1 dB threshold. Soil moisture is nevertheless calcu-

lated. This bit is useful to mask densely vegetated areas.

- *Bit 3 set:* Azimuthal noise above limit, i.e. ESD (the estimated standard deviation) is larger than the 1 dB threshold. Soil moisture is nevertheless calculated.
- *Bit 4 set:* Backscatter for-aft beam out of range, i.e. $\sigma_f^\circ - \sigma_a^\circ > 6 \cdot ESD$ [in dB], where ESD is the estimated standard deviation. Soil moisture is nevertheless calculated.
- *Bit 5 set:* The backscatter vs. incidence angle slope of the mid-fore beam measurement pair is out of range, i.e. larger than 6 times the noise of the slope. Soil moisture is nevertheless calculated.
- *Bit 6 set:* The backscatter vs. incidence angle slope of the mid-aft beam measurement pair is out of range, i.e. larger than 6 times the noise of the slope. Soil moisture is nevertheless calculated.
- *Bit 7 set:* Original soil moisture below -20%, value delivered, but set to 0% artificially.
- *Bit 8 set:* Original soil moisture above 120%, value delivered, but set to 100% artificially.
- *Bit 9–16:* Reserved for future use.

Correction flags Correction flags (`CORRECTION_FLAGS`) are set to flag a soil moisture value provided in the product, but that has been modified after the retrieval for different reasons, according to quality criteria based on the data itself.

- *Bit 1 set:* Original soil moisture larger than or equal to -20% but less than 0%, value set to 0% artificially.
- *Bit 2 set:* Original soil moisture larger than or equal to 100% but less than 120%, value set to 100% artificially.
- *Bit 3 set:* Correction of wet backscatter reference applied.
- *Bit 4–7:* Reserved for future use.
- *Bit 8 set:* Azimuth correction was applied on backscatter coefficient.

Advisory flags

Soil moisture cannot be estimated if the fraction of dense vegetation, open water surfaces, snow or frozen soil dominates the scatterometer footprint. In order to support users in judging the quality of the soil moisture products, advisory flags are provided as complementary information advising on the validity of the soil moisture values, according to quality criteria *not* based on the data itself, but on external data sources or predictions.

Name	Scaling factor	Units	Type	Byte size
SNOW_COVER_PROBABILITY	-	-	uint8	1
FROZEN_SOIL_PROBABILITY	-	-	uint8	1
INUNDATION_OR_WETLAND	-	-	uint8	1
TOPOGRAPHICAL_COMPLEXITY	-	-	uint8	1
AGGREGATED_QUALITY_FLAG	-	-	uint8	1

Table 3.5: Advisory flag fields.

Snow cover probability Backscatter measurements are very sensitive to snow properties. The exact scattering behavior of snow depends on the dielectric properties of the the ice particles, distribution and density. Therefore, soil moisture cannot be retrieved under snow conditions. The snow cover probability (`SNOW_COVER_PROBABILITY`) was computed based on a historic analysis of SSM/I snow cover data averaged over the 9 years 1996–2004 and gives the probability for the occurrence of snow for any day of the year in percent.

Frozen soil probability Similarly to snow conditions, backscatter measurements become highly unpredictable for frozen soil. Hence, backscatter measurements from frozen soil should be masked. A flag (`FROZEN_SOIL_PROBABILITY`) based on a historic analysis of modeled climate data (1995–2001 ECMWF ERA-40 data), which gives the probability for the frozen soil/canopy condition for each day of the year.

Inundation and wetland fraction The penetration depth of C-band microwaves into water is less than about 2 mm, and backscatter dependents on the roughness of the surface. When water is calm, then specular reflection occurs and backscatter at off-nadir angles is very low. Wind generates water waves that increase scattering into the backward direction. The radar return is highest when the radar looks into the upwind or downwind direction and is smallest when it looks normal to the wind vector. Generally, open water should not affect the retrieval, if the area covered by open water surfaces is small. Nevertheless, there exist regions were the fraction of open water surfaces can become so large as to dominate the backscatter effects. To account for this, the wetland fraction is defined as the fractional coverage of inundated and wetland areas (`INUNDATION_OR_WETLAND`). These areas are derived from the Global Lakes and Wetlands Database (GLWD) Level 3 product which includes several wetland and inundation types.

Topographic complexity Backscatter from mountainous regions is prone to several distortions. Main error sources are calibration errors due to the deviation of the surface from the assumed ellipsoid, the rough terrain, the influence of permanent snow and ice cover, a reduced sensitivity due to forest and rock cover and highly variable surface conditions. The topographic complexity (`TOPOGRAPHICAL_COMPLEXITY`) indicator is derived from GTOPO30 data. The standard deviation of elevation is calculated and normalized to a value between 0% and 100%.

Aggregated quality flag The aggregated quality flag (`AGGREGATED_QUALITY_FLAG`) represents simply the maximum of the previous four flags (i.e. snow cover, frozen soil, inundation and wetland, topographic complexity). It should be used with caution, because masking for a fixed threshold will automatically assign the same level of importance to all four flags constituting the aggregated quality flag. However, in same cases masking conditions can be more relaxing for one or the other flag.

3.2 Product limitations and caveats

Product limitations and caveats are discussed in the Algorithm Theoretical Baseline Document (ATBD) [RD-1].

3.3 Spatial resolution and sampling

The soil moisture orbit product is available in two spatial resolutions with different spatial sampling distances.

- Spatial sampling on a regular 12.5 km grid in orbit geometry with a spatial resolution of about 25 km × 25 km.
- Spatial sampling on a regular 25 km grid in orbit geometry with a spatial resolution of about 50 km × 50 km.

The spatial resolution is defined by the Hamming window function, which is used to for re-sample of raw backscatter measurements to the orbit grid in the Level-1 ground processor.

3.4 File format

The soil moisture orbit product is available in the Network Common Data Format (NetCDF) following the NetCDF Climate and Forecast (CF) Metadata Conventions [Eaton et al., 2011].

4 Product validation

More information can be found on the Product Validation Report (RD-2).

5 Product availability

5.1 Download

The soil moisture data records are available via FTP. Download details are available after registering at ESA data portal website [https://earth.esa.int]. If you need help with respect to data access please contact the ESA EO portal helpdesk [https://earth.esa.int/web/guest/contact-us] and for questions about the product itself please contact the TU Wien support [remote.sensing@geo.tuwien.ac.at].

5.2 Conditions of use

ERS ESCAT soil moisture products have been produced in the framework of the ESA funded project SCIRoCCo and are disseminated under ESA Data Policy. They are available for all users free of charge after registration.

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