Technical Note -
CATDS LEVEL 3 DATA PRODUCT DESCRIPTION
- Soil Moisture and Brightness Temperature -

Project code SO-TN-CB-CA-0001

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DOCUMENT STATUS SHEET

Version /Rev .	Date	Pages	Changes	Visa
Draft	10/11/2011		First draft	
1a	16/04/2012		Final report v2.44	
			Major update	
1b	24/10/2012		Modifications of the path in the ftp website	
			(§ where to find the products)	
			v2.48	
1c	23/03/13		Replacement of "P11p", "P1", etc.	
			by "daily products", "3-day products", etc.	
			v2.52	
			Update with v2.52: Addition of 2 new fields in the	
			daily product (M_Ava0 and Rfi_Prob)	
2a	24/04/13		UDP part removed as no more distributed	
			v2.52	
2b	11/09/14		Add table 3 science flag	
2c	12/09/14		Ease Grid2, V2.7.2	
3	03/03/21		Update L3TB , new reprocessing RE07	
4a	21/07/21		Add simplified SM + Update SM new reprocessing RE07	

DISTRIBUTION LIST

ESTEC/EEM:		ESRIN:		CNES:	
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RD 1 Algorithm Theoretical Baseline Document L3 SM: ATBD CATDS SM L3 SO-TN-CBSA-GS-0029

RD 2 Algorithm Theoretical Baseline Document L2 SM: SM ATBD SO-TN-ESL-SM-GS-0001(3.h)

RD 3 Data Processing Model SM PC2: CAT-DPM-CTSM-00013-CG_13

RD 4 Data Processing Model SM L3TB: CAT-DPM-CTL3TB-00061-CG

RD 5 Spécification Logicielle : CAT-SL-CT-00009-CG_10

RD 6 SMOS Level 1 and Auxiliary Data Products Specifications: SO-TN-IDR-GS-0005

ACRONYMS

ADF	Auxiliary Data File
ATBD	Algorithm Theoretical Baseline Document
CATDS	Centre Aval de Traitement des Données SMOS
CESBIO	Centre d'Etudes Spatiales de la Biosphère
CCFSMF	Processor Configuration parameters for L2 Soil Moisture, full polarisation
DPM	Data Processing Model
DQX	Data Quality Index
EASE	Equal-Area Scalable Earth Grid
ECMWF	European Centre for Medium-range Weather Forecasting
FL	Flag
LSB / MSB	Lowest / Most Significant Bit *
MD	Cardioid Model
RFI	Radiometric Frequency Interference
SM	Soil Moisture
SMOS	Soil Moisture and Ocean Salinity
Tau	Vegetation Optical thickness
TB/BT	Brightness Temperature
TEC	Total Electron Content

Contents

1 INTRODUCTION

The ESA's (European Space Agency) SMOS (Soil Moisture and Ocean Salinity) mission, operating since November 2009, is the first satellite dedicated to measuring surface soil moisture and ocean salinity. The CNES (Centre National d'Etudes Spatiales) has developed a ground segment for the SMOS data, known as the CATDS (Centre Aval de Traitement des Données SMOS). Operational since June 2011, it provides data referred to as level 3 products at different temporal resolutions: daily products (see Figure 1), 3 day global products insuring a complete coverage of the Earth surface, 10-day composite products, and monthly averaged products. For each day, there are at most 15 ascending (respectively descending) half-orbits. It always corresponds to the local equator crossing solar time 6:00 am (resp. 6:00 pm).

Like the AMSR-E L3 data, these products are presented in the NetCDF format on the EASE (Equal Area Scalable Earth) grid version 2 with a ~25 km cylindrical projection. On equal-area maps, the grid is changing with latitude: a circle placed anywhere on the map always covers the same area on the globe (here 625 km^2), and the product of the scale h along a meridian and the scale k along a parallel is always equal to one. Its dimension, i.e. the aspect ratio k/h measures the distortion of the shape. The global EASE grid is characterized by h=k at a latitude of +/-30°. It insures a minimum mean angular distortion over continents. For more information on the EASE grid see the ATBD L3SM [1]. An inversion algorithm is applied to the set of the brightness temperatures from global daily L1C product. This processing is an iterative scheme performed in order to minimize a quadratic cost function. It is exactly derived from the L2 SM algorithm in the principles. The major enhancement at CATDS concerns the use of multi-orbit retrieval: several revisits are taken into account simultaneously, one chosen in the three days before the reference day and another in the three days after.

ABOUT THE PRODUCTS
There are seven different types of Level 3 products distributed: the Brightness Temperature product (named L3TB), the one day global map of soil moisture values (named daily products), the global soil moisture products, 3-day global map (named 3-day products for Surface Soil Moisture), the dielectric constant products, 3-day global map (named 3-day products for Dielectric Constant), the global soil moisture products, 10-day global map (named 10-day products), and the global soil moisture products, monthly global map (named monthly products).

WHERE TO FIND THE PRODUCTS
All the products can be found on the CATDS website (http://catds.fr), in an organisation depending on the type of product. The Level 3 Brightness Temperature, the daily products and all the aggregated products (3-day, 10-day and monthly products) are stored following the organisation shown on figures 2 to 8.
    FTP access
    The CATDS-CPDC products are freely available on FTP :
    ftp ftp.ifremer.fr
    user : ext-catds-cpdc
    password : catds2010
    or
    ftp://ext-catds-cpdc:catds2010@ftp.ifremer.fr/

VERSION OF THE PRODUCTS
There are several changes in the products for each update of the version, some have minor impacts, some have more important ones. This document will be updated accordingly.

This document is written for the V330 We strongly recommend to use the last set of reprocessed data which are in the folder "RE07" on the CATDS website.

e.g: SM_OPER_MIR_CLF3MD_220130201T000000_20130228T235959_330_001_7 in this product, the version of the processor is V330.

Overview

Maps of the various products can be seen here :
https://maps.catds.fr/

2   LEVEL 3 BRIGHTNESS TEMPERATURE PRODUCT - L3TB

2.1   Product Description

The Level 3 Brightness Temperature product is a daily global polarised brightness temperature product, arranged by incidence angle values, in full polarisation. It includes all brightness temperatures acquired that day, transformed to ground polarisation reference frame (H and V polarisation), binned (5°) and averaged into fixed angle classes. Bin 9 corresponds to SMAP incidence angle (40° +/- 2°), bin 15 is a place holder for the time being. Ascending and descending orbits are processed separately and only in full polarisation.

2.2   Naming Convention

All the files are named as follows:
"SM_OPER_MIR_CDF3Tx_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvv_ccc_n", where the conventions are very close to those of SMOS Level 2.
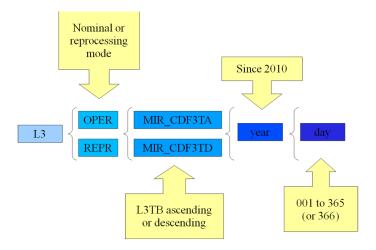
Table 1: Naming Description of the L3 Brightness Temperatures Product

SM	in this specific case, it stands for the SMOS mission
OPER REPR	file class: indicates whether the data is produced in a nominal or a reprocessing mode
MIR	file category: MIRAS, as the name of the instrument
CDF3Tx	C = CATDS D = for daily nominal product F = for full polarisation 3T = Level 3 Brightness Temperature Products x = "A" for ascending orbit and "D" for descending orbit
yyyymmddThhmmss	sensing start time for the data contained in the product With yyyy year mm month dd day of the month hh hour mm minutes ss seconds
vvv	version number of the processor generating the product
ccc	file counter, used to make distinction among products having all other filename identifiers identical: the higher the file counter, the more recent the product
n	processing site (C-PDC=7, C-EC SM=8, C-EC OS=9)

2.3   Where to find these products

These products can be found on the CATDS website (http://catds.fr), ftp://ext-catds-cpdc:catds2010@ftp.ifremer.fr/ organised as follows:
SM/GRIDDED/L3/OPER/product type/year/day of the year, where product type can be MIR_CDF3TA or MIR_CDF3TD depending on orbits type, and day of the year is between 001 (1st January) and 365/366 (31st December).

2.4 Product content

Table 2: Content of the L3 Brightness Temperatures Product

Variable Name	Description
lat and lon	Geographic coordinates: Vectors of latitudes and longitudes (in degree) of the grid point. The dimensions of "lat" and "lon" are 584x1 and 1388x1 respectively, corresponding to the 584x1388 nodes of the EASE version 2, 25km cylindrical grid.
inc and dinc	Centre (inc) and width (dinc) of each class of angle in degree. Their dimensions are 15x1
The 2 following parameters are presented as a 584x1388 matrix	
X_Swath	Abscissa of the dwell line (in km): The sign of the value is relative to the direction of the satellite. It is positive if it is to the right and negative if it is to the left of the satellite subtrack
Grid_Point_Mask	Flag indicating land/sea USGS content, coastline distance, and Ice content. See at the end of the document for a complete description of this flag
All the following parameters have 3 dimensions: 15x584x1388	
BT_H, BT_V BT_3, BT_4	Averaged brightness temperature (in Kelvin) by angle class in H-pol, V-pol, 3rd Stokes parameter and 4th Stokes parameter respectively, over current Earth fixed grid point, obtained by rotating the L1c data
Pixel_Radiometric_Accuracy_H Pixel_Radiometric_Accuracy_V Pixel_Radiometric_Accuracy_3	Error accuracy measurement (in Kelvin) associated to the averaged brightness temperature by class of angle presented in the previous field, extracted in

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Pixel_Radiometric_Accuracy_4	the direction of the pixel.
Pixel_BT_Standard_Deviation_H Pixel_BT_Standard_Deviation_V Pixel_BT_Standard_Deviation_3 Pixel_BT_Standard_Deviation_4	Brightness temperature standard deviation (in Kelvin) by class of angle.
Incidence_Angle	Incidence angle value (in degree) by class of angle corresponding to the measured BT values over current Earth fixed grid point
Azimuth_Angle	Azimuth angle value (in degree) by class of angle corresponding to the measured brightness temperature value over current Earth fixed grid point
Footprint_Axis1 Footprint_Axis2	Elliptical averaged footprint major (and minor respectively) semi-axis value by class of angle. Averaged direction cosine for Xi and Eta, respectively, by angle class
Xi and Eta	Xi and Eta referred to the antenna frame
Nviews	Number of brightness temperature views used to compute angle class averages.
Days UTC_Seconds UTC_Microseconds	Measurement acquisition time in UTC at which the averaged brightness temperature was taken Day count begins on the 1st of January 2000 seconds and microseconds are relative to the current day in UTC
Nb_RFI_Flags	Number of views flagged as potentially contaminated by RFI
Nb_SUN_Flags	Number of views flagged as contaminated by the sun

3   SIMPLIFIED DAILY SOIL MOISTURE

3.1   Product Description

The S simplified daily product, is a lighter version of the daily product with 2 new fields that are the number of TB used to perform the retrieval and the RFI

3.2   Naming Convention

All the files are named as follows:
"SM_OPER_MIR_CLF3Sx_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvv_ccc_n", where the conventions are very close to those of SMOS Level 2.

Table 3: Naming Description of the Daily SM-VOD Product

SM	in this specific case, it stands for the SMOS mission
OPER REPR	file class: indicates whether the data is produced in a nominal or a reprocessing mode
MIR	file category: MIRAS, as the name of the instrument
CLF3Sx	C = CATDS L = Product over Land F = for full polarisation 3S = Level 3, S stands for simplified, i.e. daily global maps x = "A" for ascending orbit and "D" for descending orbit
yyyymmddThhmmss	sensing start time for the data contained in the product With yyyy year mm month dd day of the month hh hour mm minutes ss seconds
vvv	version number of the processor generating the product
ccc	file counter, used to make distinction among products having all other filename identifiers identical: the higher the file counter, the more recent the product
n	processing site (C-PDC=7, C-EC SM=8, C-EC OS=9)

3.3 Where to find these products

3.4 Product content

Table 4: Content of the L3 Brightness Temperatures Product

Variable Name	Description
lat and lon	Geographic coordinates: Vectors of latitudes and longitudes (in degree) of the grid point. The dimensions of "lat" and "lon" are 584x1 and 1388x1 respectively, corresponding to the 584x1388 nodes of the EASE version 2, 25km cylindrical grid.
The 2 following parameters are presented as a 584x1388 matrix	
X_Swath	Abscissa of the dwell line (in km): The sign of the value is relative to the direction of the satellite. It is positive if it is to the right and negative if it is to the left of the satellite subtrack
Days UTC_Seconds	Measurement acquisition time in UTC at which the averaged brightness temperature was taken, in Day count begins on the 1st of January 2000 seconds are relative to the current day in UTC

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Soil_Moisture	Soil Moisture (m3/m3)
Soil_Moisture_Dqx	SM Data Quality Index, is a measure of the uncertainty due to SMOS radiometric accuracy
Optical_Thickness_Nad	VOD (-) is the τ parameter in the Radiative Transfert Model
Optical_Thickness_Nad_Dqx	VOD Data Quality index, is the uncertainty on the derived VOD due to SMOS radiometric accuracy
Science_Flags	is binary sequence describing conditions
Mean_FM0_FNO	Fraction of Nominal land cover over SMOS footprint, based on IGBP maps with the antenna pattern being applied
Mean_FM0_FFO	Fraction of Forest land cover over SMOS footprint, based on IGBP maps with the antenna pattern being applied
Number_Degree_Freedom	is the number of degree of freedom used for the retrieval is the number of TB - number of free parameters
M_Ava	is the number of TB (after filtering) used for that orbits
Ratio_RFI	is the fraction of contaminated TB for that day is defined as the some of NRFIX and NRFIY for the 3 orbits devided by the number of initial TB (acquired, i.e before filtering)
Chi_2	Statistic that measure the goodness of the fit modeled TB with derived SM and VOD versus SMOS TB
Chi_2_P	Chi 2 probability
Rfi_Prob	RFI probability computed over a 12-day time window

Science Flags
This parameter is coded in 32 bits: the reported value has to be converted to a binary number.

Table 5: Science_Flags

Bit(1 - > (LSB)	Tag Name	Type
1	FL_Non_Nom	This flag is set to 1 if any of the flags in Bits 3 to 10 and 12 to 20 in this table is raised
2	FL_Scene_T	This flag is set to 1 when either FL_Non_Nom or FL_Nominal is raised
3	FL_Barren	This flag is set to 1 when the radiometric fraction of Barren surface is > TH_SCENE_FEB (5.00%)
4	FL_Topo_S	This flag is set to 1 if the radiometric fraction of Strong Topography is > TH_SCENE_FTS (5.00%)
5	FL_Topo_M	This flag is set to 1 if the radiometric fraction of Moderate Topography is > TH_SCENE_FTM (10.00%)

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6	FL_OW	This flag is set to 1 if the radiometric fraction of Open Water is > TH_SCENE_FOW (5.00%)
7	FL_Snow_Mix	This flag is set to 1 if the radiometric fraction of Mixed Snow is > TH_SCENE_FSN (5.00%)
8	FL_Snow_Wet	This flag is set to 1 if the radiometric fraction of Wet Snow is > TH_SCENE_FSW (5.00%)
9	FL_Snow_Dry	This flag is set to 1 if the radiometric fraction of Dry Snow is > TH_SCENE_FSD (5.00%)
10	FL_Forest	This flag is set to 1 if the radiometric fraction of Forest is > TH_SCENE_FFO (10.00%)
11	FL_Nominal	This flag is set to 1 if the radiometric fraction of Nominal is > TH_SCENE_FNO (10.00%)
12	FL_Frost	This flag is set to 1 if the radiometric fraction of Frost is > TH_SCENE_FRZ (5.00%)
13	FL_Ice	This flag is set to 1 if the radiometric fraction of Total Ice is > TH_SCENE_FTI (5.00%)
14	FL_Wetlands	This flag is set to 1 if the radiometric fraction of Wetlands is > TH_SCENE_FWL (5.00%)
15	FL_Flood_Prob	This flag is set to 1 if the sum of the ECMWF value for Large_Scale_Precipitation and Convective_Precipitation (AUX_ECMWF_) is > threshold TH_FLOOD (20mm/h)
16	FL_Urban_Low	This flag is set to 1 if the radiometric fraction of Urban is > TH_SCENE_FUL (10.00%)
17	FL_Urban_High	This flag is set to 1 when the radiometric fraction of Urban is > TH_SCENE_FUH (30.00%)
18	FL_Sand	This flag is set to 1 if the mean sand fraction is > TH_Sand (95.00%) The mean sand fraction is computed as the non-weighted average of the sand % from the Soil Properties product
19	FL_Sea_Ice	This flag is set to 1 if the radiometric fraction of Sea Ice surface type, which is determined by the sea ice cover of the ECMWF database, is > TH_Sea_Ice (20.00%).
20	FL_Coast	This flag is set to 1 when the Wetlands fraction in at least one DFFG cell in the working area is above zero and the Land Cover Class reports an intertidal area.
21	FL_Occur_T	This flag is set to 1 if any of the FL_Litter, FL_PR, or FL_Intercep is raised, indicating the occurrence of a special event during the retrieval.
22	FL_Litter	This flag is set to 1 if the mean litter opacity is above the threshold TH_TAU_Litter (0.10 neper)
23	FL_PR	This flag is set to 1 if the interception index is below the threshold TH_PR (0.026)
24	FL_Intercep	This flag is set to 1 if the ECMWF parameter Skin_Reservoir_Content (SCR) is > TH_Intercep (0.02)
25	FL_External	This flag is set to 1 if one of the flags FL_Rain, FL_TEC is raised or N_Sky > 0
26	FL_Rain	This flag is set to 1 if the sum of the ECMWF parameters Large_Scale_Precipitation and Convective_Precipitation (LSP and CP) is > TH_RAIN (10.00 mm/h)
27	FL_TEC	This flag is raised if the TEC (Total Electric Constant) content

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		of the first snapshot contributing to the brightness temperature measurements to the last retrieval is > TH_TEC $(95 \times 10^{16}$ electrons/m^2). If no retrieval has been attempted then the brightness temperatures are those used to compute MVAL0
28	FL_TAU_FO	This flag is set to 1 if the mean forest opacity is > TH_SCENE_TAU_FO (1.0 neper)
29	FL_WINTER_FOREST	Flag indicating that the forest case has been selected by the decision tree despite the fact that the mean fraction is mainly in the FNO case
30	FL_DUAL_RETR_FNO_FFO	dual retrieval performed on the FNO and FFO fractions
31-32		Two spare bits

4   DAILY SOIL MOISTURE

4.1   Product Description

This product is the one day product, and contains filtered data. The best estimation of soil moisture and dielectric constant are selected (based on the minimisation of the DQX) for each node when several multi-orbit retrievals are available for a given day. A detection of particular events is also performed in order to flag the data aggregation of SMOS orbits. Ascending and descending orbits are still processed separately. All the aggregated products (3-day, 10-day and monthly products) are based on these daily maps.

4.2   Naming Convention

All the files are named as follows:
"SM_OPER_MIR_CLF31x_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvv_ccc_n", where the conventions are very close to those of SMOS Level 2.
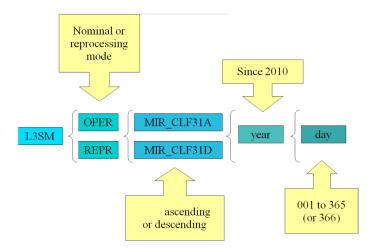
Table 6: Naming Description of the Daily SM-VOD Product

SM	in this specific case, it stands for the SMOS mission
OPER REPR	file class: indicates whether the data is produced in a nominal or a reprocessing mode
MIR	file category: MIRAS, as the name of the instrument
CLF31x	C = CATDS L = Product over Land F = for full polarisation 31 = Level 3, 1 stands for 1 day, i.e. daily global maps x = "A" for ascending orbit and "D" for descending orbit
yyyymmddThhmmss	sensing start time for the data contained in the product With yyyy year mm month dd day of the month hh hour mm minutes ss seconds
vvv	version number of the processor generating the product
ccc	file counter, used to make distinction among products having all other filename identifiers identical: the higher the file counter, the more recent the product
n	processing site (C-PDC=7, C-EC SM=8, C-EC OS=9)

4.3   Where to find these products

These products can be found on the CATDS website (http://catds.fr), organised as follows:
SM/GRIDDED/L3SM/OPER/product type/year/day of the year,
where product type can be MIR_CLF31A or MIR_CLF31D depending on orbits type, and day of the year is between 001 (1st January) and 365/366 (31st December).

4.4 Product content

Table 7: Content of the L3 Daily SM Product

Variable Name	Description
lat and lon	Geographic coordinates: Vectors of latitudes and longitudes (in degree) of the grid point. The dimensions of "lat" and "lon" are 584x1 and 1388x1 respectively, corresponding to the 584x1388 nodes of the EASE version 2, 25km cylindrical grid.
The 2 following parameters are presented as a 584x1388 matrix	
Mean_Acq_Time_Days Mean_Acq_Time_Seconds	Time of measurement: Day and second of mean acquisition time per DGG node, corresponding to the selected soil moisture value. Day count begins on the 1st of January 2000 AD, seconds and microseconds are relative to the current day in UTC.
Mean_Acq_Time_Days2 Mean_Acq_Time_Seconds2	Time of measurement in UTC: Day and the second of mean acquisition time per DGG node, corresponding to the selected dielectric constant value. Day count begins on the 1st of January 2000 seconds and microseconds are relative to the current day in UTC
Soil_Moisture Soil_Moisture_Dqx	is the retrieved soil moisture value (in m^3/m^3) its associated data quality index (in m^3/m^3)
Optical_Thickness_Nad	The nadir optical thickness of the vegetation layer (in neper) corresponding to the derived soil moisture values
Optical_Thickness_Nad_Dqx	its associated data quality index
Optical_Thickness_Nad2	The nadir optical thickness of the vegetation layer (in neper) corresponding to the derived dielectric constant values
Optical_Thickness_Nad2_Dqx	its associated quality index
Dielectric_Const Dielectric_Const_Dqx	Real and imaginary parts of the dielectric constant retrieved from the cardioid model (MD) in Fm^{-1}, and their associated data quality index.

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Dimensions of this parameter are 584x1388x2 (for real and imaginary parts).

Hr	Retrieved surface roughness parameter
Hr_Dqx	its associated data quality index
Scattering_Albedo_H	Spare, not retrieved at the moment
Diff_Albedos	
Dqx	
Surface_Temperature	Retrieved surface temperature (in Kelvin)
Surface_Temperature_Dqx	its associated quality index corresponding to
	the derived soil moisture values.
Temp_STL1	ECMWF temperatures used for the 0-7 cm soil layer and the soil surface
Temp_SKT	respectively, corresponding to the derived soil moisture
S_Tree_1	Permanent surface category: This represents the considered retrieval case
	of the decision tree, i.e. the main surface cover type (see ATBD L2SM)
	* Only 11 and 12 are of interest for soil moisture retrieval.
	1. all open water
	2. heterogeneous open water
	3. strong topography pollution
	4. soft topography pollution
	5. all wet snow
	6. all mixed snow
	7. wet snow pollution
	8. mixed snow pollution
	9. all frost
	10. frost pollution
	11. forest cover
	12. soil cover
	13. all wetlands
	14. all barren
	15. all ice
	16. all urban
	17. heterogeneous
Tb_Asl_Theta_B_H	Brightness temperature At Surface Level in Kelvin
Tb_Asl_Theta_B_H_Dqx	corrected for sky/atmosphere contribution
Tb_Asl_Theta_B_V	provided at the Earth reference frame
Tb_Asl_Theta_B_V_Dqx	Computed using the forward model at the specific incidence angle
	theta_B of 42.5 ^{o}, for H and V polarisations
	and their associated data quality index.
Tb_Toa_Theta_B_X	Brightness temperature at the Top Of the Atmosphere in Kelvin
Tb_Toa_Theta_B_X_Dqx	corrected for sky/atmosphere contribution and transferred
Tb_Toa_Theta_B_Y	to antenna reference frame (X, Y polarisations)
Tb_Toa_Theta_B_Y_Dqx	using the Faraday and geometric rotation computed from the forward models
	at the specific incidence angle theta_B of 42.5^o
	and their associated data quality index

Science_Flags	They are the flags associated with the soil moisture value (see table) This parameter is coded in 32 bits: the reported value has to be converted to a binary sequence
Fno and Ffo	Fractions of nominal (i.e. low vegetation and sand) and forest as radiometric fractions or each node corresponding to the derived SM.
M_Ava0	Total number of brightness temperature measurements acquired for each nodes corresponding to the selected soil moisture values.
M_Ava	Total number of brightness temperature measurements actually considered for the retrieval after initial filterings corresponding to the selected SM.
N_Rfi_X N_Rfi_Y	Number of discarded brightness temperatures due to suspected RFI in the X and Y polarisations corresponding to the derived soil moisture.
Min_Soil_Moisture Max_Soil_Moisture Min_Soil_Moisture_Dqx Max_Soil_Moisture_Dqx	As several soil moisture data (and thus data quality indexes) are available per node and per day, the minimum and the maximum values are reported
Soil_Moisture_Init_Val Soil_Moisture_Init_Std	Initial value and the standard deviation for free parameter soil moisture corresponding to the derived soil moisture
Gqx Gqx2	Global quality indexes associated with the soil moisture values and the dielectric constant values, respectively.
Event_Flags	Flag about event detection: This parameter is coded in 16 bits using the following convention: 00 Not verified 01 : Possible 10 : Sure 11 : Not processed The first two ones (FL_EV_Frost_Soil) are raised to show the possible existence of ground frozen, the 14 other ones are spare bits padded with 0. *e.g.: "0000000000000010" (=2 in a decimal system) means that frost has been clearly detected on the ground*
Rfi_Prob	RFI probability: total number of RFI detected on a large period divided by the total number of brightness temperature measurements acquired on the same period.

5 3-DAY SM-VOD PRODUCT

5.1 Product Description

The 3-day global product of soil moisture is an aggregation of daily global maps of soil moisture and its associated parameters over a 3 day moving window. The whole Earth's surface is covered in this 3-day product. This product is based on the best soil moisture retrievals (minimisation of the DQX). The distinction between ascending and descending orbits is kept.

5.2 Naming Convention
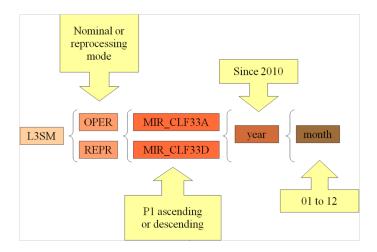
All the files are named as follows:
"SM_OPER_MIR_CLF33x_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvv_ccc_n", where the conventions are very close to those of SMOS Level 2.

Table 8: Naming Description of the 3-day SM-VOD Product

SM	in this specific case, it stands for the SMOS mission
OPER REPR	file class: indicates whether the data is produced in a nominal or a reprocessing mode
MIR	file category: MIRAS, as the name of the instrument
CLF33x	C = CATDS L = Product over Land F = for full polarisation 33 = Level 3, 3 stands for 3-day global maps x = "A" for ascending orbit and "D" for descending orbit
yyyymmddThhmmss	sensing start time for the data contained in the product With yyyy year mm month dd day of the month hh hour mm minutes ss seconds
vvv	version number of the processor generating the product
ccc	file counter, used to make distinction among products having all other filename identifiers identical: the higher the file counter, the more recent the product
n	processing site (C-PDC=7, C-EC SM=8, C-EC OS=9)

5.3 Where to find these products

These products can be found on the CATDS website (http://catds.fr), organised as follows:
SM/GRIDDED/L3SM/OPER/product type/year/month,
where product type can be MIR_CLF33A or MIR_CLF33D depending on orbits type.

5.4   Product content

Table 9: Content of the 3-Day Product

Variable Name	Description
lat and lon	Geographic coordinates: Vectors of latitudes and longitudes (in degree) of the grid point. The dimensions of "lat" and "lon" are 584x1 and 1388x1 respectively, corresponding to the 584x1388 nodes of the EASE version 2, 25km cylindrical grid.
The 2 following parameters are presented as a 584x1388 matrix	
Nb_Sm	Number of available soil moisture estimates obtained over the 3 day period: It could vary from 0 to 3 if the point is successfully retrieved over the 3 days.
Soil_Moisture Soil_Moisture_Dqx	Selected soil moisture value for the period: The selected soil moisture value (in m^3/m^3) with the smallest CHI2 is kept between all the values (maximum 3) available during the period for one DGG and its associated data quality index.
Nominal_Fraction	Nominal fraction associated with the selected soil moisture values.
Optical_Thickness_Nad Optical_Thickness_Nad_Dqx	Vegetation opacity and its DQX corresponding to the selected SM
Science_Flags	Flags associated with the selected soil moisture values
Event_Flags	Flag about event detection This parameter is coded in 16 bits, using the following convention: 00 : Not verified 01 : Possible 10 : Sure 11 : Not processed The first two ones (FL_EV_Frost_Soil) are raised to show the possible existence of ground frozen, and the 14 other ones are spare bits padded with 0 *e.g. "0000000000000010" (=2 in a decimal system) means that frost has been*

clearly detected on the ground.

Gqx	Global quality index associated with the selected soil moisture value.

Mean_Acq_Time_Days
Mean_Acq_Time_Seconds

Time of measurement in UTC as Day and second of mean acquisition time, per DG
corresponding to the selected soil moisture value.
Day count begins on the 1st of January 2000
seconds and microseconds are relative to the current day in UTC

Dielectric_Const
Dielectric_Const_Dqx

Real and imaginary parts of the dielectric constant retrieved from the
cardioid model (MD) in Fm^{-1} and their associated data quality index
The dimensions of this parameter are 584x1388x2 (for real and imaginary parts).

list_of_data_set

This is the list of the daily products used in the processing.

6   3-DAY DIELECTRIC CONSTANT PRODUCT

6.1   Product Description

The 3-day global product of the dielectric constant is an aggregation of daily maps of dielectric constant and its associated parameters over 3 days moving window. The whole Earth's surface is covered in this 3-day product. This product is based on the best dielectric constant retrievals (minimisation of the DQX). The distinction between ascending and descending orbits is kept.

6.2   Naming Convention
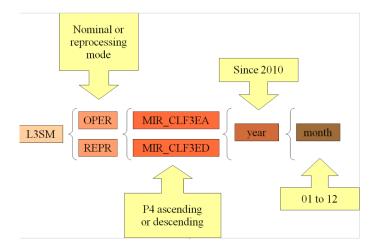
All the files are named as follows:
"SM_OPER_MIR_CLF3Ex_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvv_ccc_n", where the conventions are very close to those of SMOS Level 2.

Table 10: Naming Description of the Daily SM-VOD Product

SM	in this specific case, it stands for the SMOS mission
OPER REPR	file class: indicates whether the data is produced in a nominal or a reprocessing mode
MIR	file category: MIRAS, as the name of the instrument
CLF3Ex	C = CATDS L = Product over Land F = for full polarisation 3E = Level 3, E stands for dielectric, 3-day dielectric constant global maps x = "A" for ascending orbit and "D" for descending orbit
yyyymmddThhmmss	sensing start time for the data contained in the product With yyyy year mm month dd day of the month hh hour mm minutes ss seconds
vvv	version number of the processor generating the product
ccc	file counter, used to make distinction among products having all other filename identifiers identical: the higher the file counter, the more recent the product
n	processing site (C-PDC=7, C-EC SM=8, C-EC OS=9)

6.3   Where to find these products

These products can be found on the CATDS website (http://catds.fr), organised as follows:
SM/GRIDDED/L3SM/OPER/product type/year/month,
where product type can be MIR_CLF3EA or MIR_CLF3ED depending on orbits type.

6.4 Product content

Table 11: Content of 3-Day Dielectric Constant Product

Variable Name	Description
lat and lon	Geographic coordinates: Vectors of latitudes and longitudes (in degree) of the grid point. The dimensions of "lat" and "lon" are 584x1 and 1388x1 respectively, corresponding to the 584x1388 nodes of the EASE version 2, 25km cylindrical grid.
The 2 following parameters are presented as a 584x1388 matrix	
Dielectric_Const Dielectric_Const_Dqx	Dielectric constant: Real and imaginary parts of the dielectric constant retrieved from the cardioid model (MD) respectively a non cardioid model (Non MD), in Fm^{-1}, and their associated data quality index. The dimensions of this parameter are 584x1388x2 (for real and imaginary parts). Between all the values (maximum 3) available for one DGG, the value with the smallest CHI2 is kept in the 3-day product for Dielectric Constant with its associated Dqx.
Dielect_Const_Module Dielect_Const_Module_Dqx	the module of dielectric constant the module of Dqx of dielectric constant
Optical_Thickness_Nad Optical_Thickness_Nad_Dqx	Vegetation opacity: Once the dielectric constant value has been selected between the available retrievals the associated optical thickness estimated for vegetation layer (in neper) and its associated quality index are reported, namely Optical_Thickness_Nad2 and Optical_Thickness_Nad_Dqx2 from the daily product
Mean_Acq_Time_Days Mean_Acq_Time_Seconds	Time of measurement in UTC: Day and second of mean acquisition time, per DGG corresponding to the selected dielectric constant values. Day count begins on the 1st of January 2000 seconds and microseconds are relative to the current day in UTC
Event_Flags	Flag about event detection

Continued on next

This parameter is coded in 16 bits, using the following convention:
00 : Not verified
01 : Possible
10 : Sure
11 : Not processed
The first two ones (FL_EV_Frost_Soil) are raised to show the possible existence of ground frozen, and the 14 other ones are spare bits padded with 0 *e.g. "0000000000000010" (=2 in a decimal system) means that frost has been clearly detected on the ground.*

list_of_data_set   This is the list of the daily products used in the processing.

7   10-DAY PRODUCT

7.1   Product Description

The 10-day global product is a 10-days aggregation of daily global maps. Three products are obtained per month whereof the last one has a duration of 8 to 11 days. Each product contains the median, minimum and maximum values of soil moisture and its associated parameters over the 10 days. The distinction between ascending and descending orbits is kept.

7.2   Naming Convention

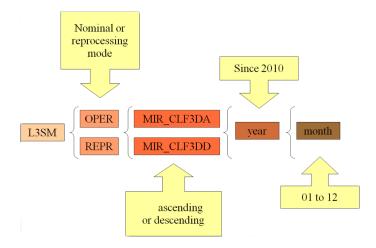All the files are named as follows:
"SM_OPER_MIR_CLF3Dx_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvv_ccc_n", where the conventions are very close to those of SMOS Level 2.

Table 12: Naming Description of the Daily SM-VOD Product

SM	in this specific case, it stands for the SMOS mission
OPER REPR	file class: indicates whether the data is produced in a nominal or a reprocessing mode
MIR	file category: MIRAS, as the name of the instrument
CLF3Dx	C = CATDS L = Product over Land F = for full polarisation 3D = Level 3, D stands for 10-days global maps x = "A" for ascending orbit and "D" for descending orbit
yyyymmddThhmmss	sensing start time for the data contained in the product With yyyy year mm month dd day of the month hh hour mm minutes ss seconds
vvv	version number of the processor generating the product
ccc	file counter, used to make distinction among products having all other filename identifiers identical: the higher the file counter, the more recent the product
n	processing site (C-PDC=7, C-EC SM=8, C-EC OS=9)

7.3   Where to find these products

These products can be found on the CATDS website (http://catds.fr), organised as follows:
SM/GRIDDED/L3SM/OPER/product type/year/month, where product type can be MIR_CLF3DA or MIR_CLF3DD depending on orbits type.

7.4 Product content

Table 13: Content of the 10-day SM-VOD Product

Variable Name	Description
lat and lon	Geographic coordinates: Vectors of latitudes and longitudes (in degree) of the grid point. The dimensions of "lat" and "lon" are 584x1 and 1388x1 respectively, corresponding to the 584x1388 nodes of the EASE version 2, 25km cylindrical grid.
The 2 following parameters are presented as a 584x1388 matrix	
Nb_Sm	Number of available soil moisture estimates obtained over the 10-day period It could vary from 0 to 11 (last 10 days can be 8 to 11 days) if the point is successfully retrieved for the 10 days
Gqx	This is the global quality index
All the following parameters have 3 dimensions: 584x1388x3 (med_min_max = 3) corresponding to the median, the minimum, and the maximum SM obtained over the 10-day period.	
Soil_Moisture Soil_Moisture_Dqx	This is the medain, minimum and maximum value of soil moisture (in $m^3.m^{-3}$) retrieved over the 10 days, and its associated data quality index.
Mean_Acq_Time_Days Mean_Acq_Time_Seconds	Time of measurement Day and second of mean acquisition time, per DGG node Day count begins on the 1st of January 2000 seconds and microseconds are relative to the current day in UTC
Optical_Thickness_Nad Optical_Thickness_Nad_Dqx	nadir optical thickness estimate for vegetation layer (in neper) its associated data quality index
Hr Hr_Dqx	the retrieved roughness its associated quality index
Scattering_Albedo_H Diff_Albedos	Spare, not retrieved at the moment

Continued on next page

Dqx

Nominal_Fraction	Fraction of nominal surface
Science_Flags	They are the flags associated with the median, the minimum and the maximum values of SM
list_of_data_set	This is the list of the daily products used in the processing.

8 MONTHLY PRODUCT

8.1 Product Description

The monthly global product of soil moisture is a monthly average of daily global maps. It provides a mean retrieved soil moisture weighted by their accuracy (DQX), vegetation optical thickness (separated for lower vegetation and forest), RFI statistics over a month, without taking into account estimations affected by detected event (only frost for the moment) in the daily product. It can be useful for climate monitoring. The distinction between ascending and descending orbits is kept.

8.2 Naming Convention
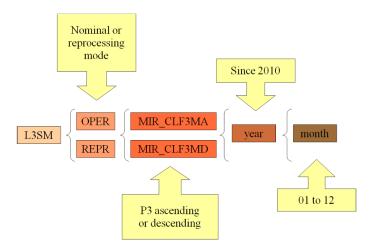
All the files are named as follows:
"SM_OPER_MIR_CLF3Mx_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvv_ccc_n", where the conventions are very close to those of SMOS Level 2.

Table 14: Naming Description of the Monthly SM-VOD Product

SM	in this specific case, it stands for the SMOS mission
OPER REPR	file class: indicates whether the data is produced in a nominal or a reprocessing mode
MIR	file category: MIRAS, as the name of the instrument
CLF3Mx	C = CATDS L = Product over Land F = for full polarisation 3M = Level 3, M stands for Monthly global maps x = "A" for ascending orbit and "D" for descending orbit
yyyymmddThhmmss	sensing start time for the data contained in the product With yyyy year mm month dd day of the month hh hour mm minutes ss seconds
vvv	version number of the processor generating the product
ccc	file counter, used to make distinction among products having all other filename identifiers identical: the higher the file counter, the more recent the product
n	processing site (C-PDC=7, C-EC SM=8, C-EC OS=9)

8.3 Where to find these products

These products can be found on the CATDS website (http://catds.fr), organised as follows:
SM/GRIDDED/L3SM/OPER/product type/year/month, where product type can be MIR_CLF3MA or MIR_CLF3MD depending on orbits type.

8.4 Product content

Table 15: Content of the monthly SM-VOD Product

Variable Name	Description
lat and lon	Geographic coordinates: Vectors of latitudes and longitudes (in degree) of the grid point. The dimensions of "lat" and "lon" are 584x1 and 1388x1 respectively, corresponding to the 584x1388 nodes of the EASE version 2, 25km cylindrical grid.
The 2 following parameters are presented as a 584x1388 matrix	
Nb_Sm	Number of available soil moisture estimates obtained over the month. It could vary from 0 to the number of days in the considered month if the point is successfully retrieved over the month.
Soil_Moisture Soil_Moisture_Dqx Var_Soil_Moisture	Monthly mean soil moisture value (in m^3/m^3) weighted by DQX which does not take into account the estimations affected by an event in the daily product. It corresponds only to data whose Event_Flags is = 0 its associated quadratic mean quality index and variance.
Optical_Thickness_Lv Optical_Thickness_Lv_Dqx Var_Optical_Thickness_Lv	Monthly mean nadir optical thickness value weighted by DQX for lower vegetation (in neper) which does not take into account the estimations affected by an event in the daily product, its associated quadratic mean quality index and variance.
Optical_Thickness_Fo Optical_Thickness_Fo_Dqx Var_Optical_Thickness_Fo	Monthly mean nadir optical thickness value weighted by DQX for forest vegetation (in neper) which does not take into account the estimations affected by an event in the daily product, its associated quadratic mean quality index and variance.
Nominal_Fraction Forest_Fraction	Mean nominal and forest fractions when the model is nominal or forest Mean is weighted by the soil moisture dqx value
Gqx	Mean global quality index where soil moisture is available

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Rfi_X_Frac   Fractions of SMOS TB measurements contaminated by RFI
Rfi_Y_Frac   in X and Y polarisations

list_of_data_set   List of the daily products used in the processing

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9   Description of FLAGS

9.1   Grid_Point_Mask

USGS Sea Flag:

[X X X X : X X X 0] means that the pixel is not considered Sea in the USGS Land-Sea mask (water fraction below 95%)

[X X X X : X X X 1] means that the pixel is considered Sea in the USGS Land-Sea mask (water fraction above 95%)

USGS Land Flag:

[X X X X : X X 0 X] means that the pixel is not considered Land in the USGS Land-Sea mask (water fraction above 10%)

[X X X X : X X 1 X] means that the pixel is considered Land in the USGS Land-Sea mask (water fraction below 10%)

USGS Mixed Flag:

[X X X X : X 0 X X] means that the pixel is not considered Mixed in the USGS Land-Sea mask (water fraction below 10% OR above 95%)

[X X X X : X 1 X X] means that the pixel is considered Mixed in the USGS Land-Sea mask (water fraction above 10% AND below 95%)

200km Coastal flag:

[X X X X : 0 X X X] means that the pixel has a distance from the coast of more than 200 Km (using the MERIS uncertainty map with its coasts extended to 200km)

[X X X X : 1 X X X] means that the pixel has a distance from the coast of less than 200 Km (using the MERIS uncertainty map with its coasts extended to 200km)

100km Coastal flag:

[X X X 0 : X X X X] means that the pixel has a distance from the coast of more than 100 Km (using the MERIS uncertainty map with its coasts extended to 100km)

[X X X 1 : X X X X] means that the pixel has a distance from the coast of less than 100 Km (using the MERIS uncertainty map with its coasts extended to 100km)

40km Coastal flag:

[X X 0 X : X X X X] means that the pixel has a distance from the coast of more than 40 Km (using the MERIS uncertainty map with its coasts extended to 40km)

[X X 1 X : X X X X] means that the pixel has a distance from the coast of less than 40 Km (using the MERIS uncertainty map with its coasts extended to 40km)

Min Sea-Ice flag:

[X 0 X X : X X X X] means that the pixel does not have the full 12 months bit ICE set in the ice mask defined in the L2 AUX_DISTAN ADF

[X 1 X X : X X X X] means that the pixel have the full 12 months bit ICE set in the ice mask defined in the L2 AUX_DISTAN ADF

Max Sea-Ice flag:

[0 X X X : X X X X] means that the pixel does not have any 12 months bit ICE set in the ice mask

defined in the L2 AUX_DISTAN ADF

[1 X X X : X X X X] means that the pixel does have any 12 months bit ICE set in the ice mask defined in the L2 AUX_DISTAN ADF