COVERAGE LOSS DUE TO CALIBRATION PERIODS

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REFERENCES

Applicable documents

AD1. SMOS – Brightness Temperature Product for Browsing. SO-TN-CBSA-GS-0006.

AD2. Soil Moisture Retrieval Software – User's Guide. SMOS-TN-ACR-SA-004.

References

ACRONYMS

AF-FOV	Alias Free Field Of View
CAS	On board CAlibration System
CESBIO	Centre d'Etudes Spatiales de la BIOsphère
CNES	Centre national d'Etudes Spatiales
ECMWF	European Centre for Medium-range Weather Forecasting
ESA	European Space Agency
ESL	Expert Support Laboratory
FOV	Field Of View
GODAE	Global Ocean Data Assimilation Experiment
LICEF	Light Cost Effective Front-end
LST	Land Surface Temperature
NIR	Noise Injection Radiometer
PSU	Practical Salinity Unit
OS	Ocean Salinity
SMOS	Soil Moisture and Ocean Salinity Mission
SRD	System Requirement Document
SSS	Sea Surface Salinity
SST	Sea Surface Temperature
TB	Brightness temperature
TBC	To Be Confirmed
TEC	Total Electronic Content
UPC	Universitat Politecnica de Catalunya
WS	Wind Speed

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1. INTRODUCTION

This document assesses the impact of long and short calibration periods on the coverage of the instrument. Since the instrument cannot acquire scientific data at the same time as it is calibrating, some portions of the orbit will not be accessible to measurement. The objective of this note is to document this coverage loss as a driver in the trade off to be made between calibration and accessibility.

The next section will described what has been considered as a reference timeline for calibration. Although highly conservative, this timeline is assumed to be representative of a typical scenario. Section 3 presents the different types of scenarios that have been used for simulation of the level 1 and level 2 products, the modifications that were necessary and the analysis conducted on the simulation outputs. Results of theses simulations and analysis are presented in section 4. Last section is devoted to summary and tentative synthesis.

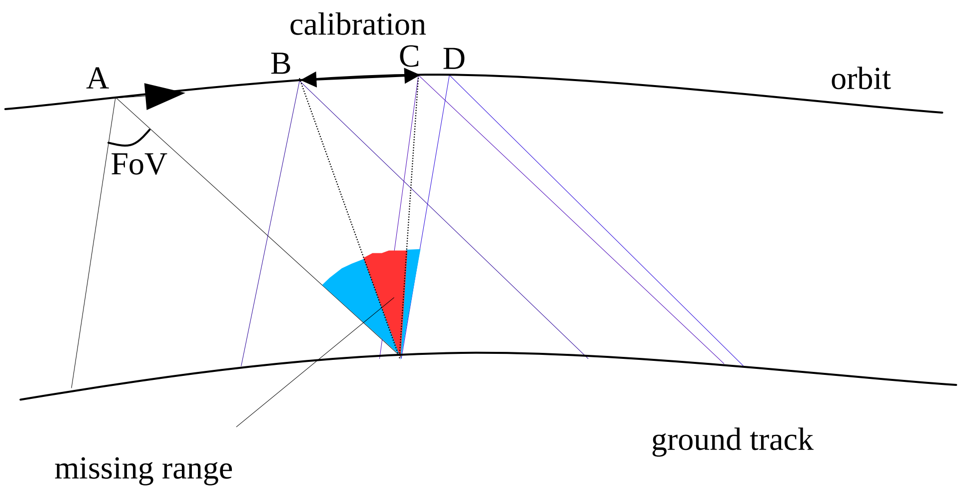
2. REFERENCE TIMELINE FOR CALIBRATION PERIODS

This timeline is described in an e-mail from Carlos Garcia Sacristan dated 26/11/2004, and runs as follows:

- 24s every 10 min devoted to correlated noise injection.
- 60s every orbit for uncorrelated noise injection.

Obviously, this timeline is conservative and short calibration are conducted very frequently, amounting to 4% of the time. Still if no correction of the physical temperature of the receivers is considered possible or unreliable, this time lime is deemed necessary to keep temperature related drifts within acceptable range.

The short calibration period is equivalent to a gap of 10 snapshots (both polarisations), the long one amounts to 25 snapshots missing.



This figure depicts the missing range in incidence angles that can be measured from SMOS on any given point. As the satellites travels on its orbit from position A to D, the incidence angle accessible to measurement over a given pixel inside the FoV varies. The distance A-D represents the maximum time during which a given point on the ground can be seen.
During the calibration period (taking place between positions B and C), acquisitions can not be made, thus leading to a missing range in incidence angles. According to the position of the pixel wrt the position on orbit at time of calibration, this missing range can affect large angles (if the pixel is downstream) or small angles (if the pixel is upstream).

3. SIMULATION SCENARIOS

Impact of coverage loss must be evaluated at both levels 1 and 2, to assess the effect of loose angular sampling on the retrieval of soil moisture as well as the effect on reducing the available number of acquisition at any given point.

The first impact, evaluated at level 1, is a reduction in the available viewing angles over any given point of the FoV. The second impact is the spin off of the first one and its implication on the retrieval process.

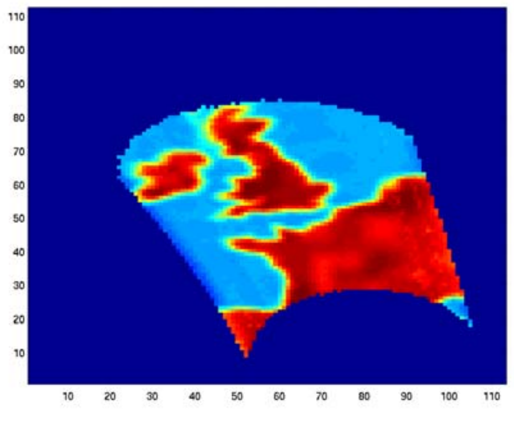
The tools used at these two levels are SEPS and SMRS.

3.1 SEPS

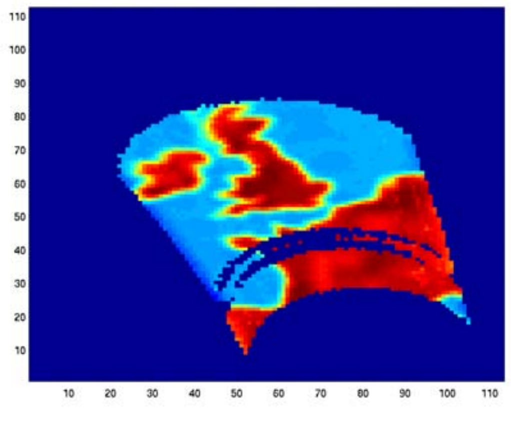
SEPS simulations are used for “mission realistic” analysis. That is to evaluate, for any given point in the instrument swath, the number of acquisitions that will be lost during calibration. Since radiometric realism is not needed in this experiment, light mode will be used for these simulations, and low resolution input maps. The simulation runs for 240s (100 snapshots) and the resulting data is temporally re sampled afterwards to simulate snapshots unavailability. The calibration period is simulated 80s after the beginning in order to avoid artefacts due to proximity of beginning or end of the simulated segment.

The simulations are conducted over Europe but the position on the orbit is obviously of no relevance for this effect. Maps of acquisition numbers and variations are produced.

The first output from these simulations is the illustration of the impact of calibration on the browse products, as shown on the figure below.



No calibration



24s calibration period

The browse products in these images are computed accordingly to the description as found in [AD1] with a constant incidence angle of 42°. The “gap-filling” effect at the edge of the swath in the right hand side figure is due to the method of computation of the browse products that allows interpolation between incidence angles.

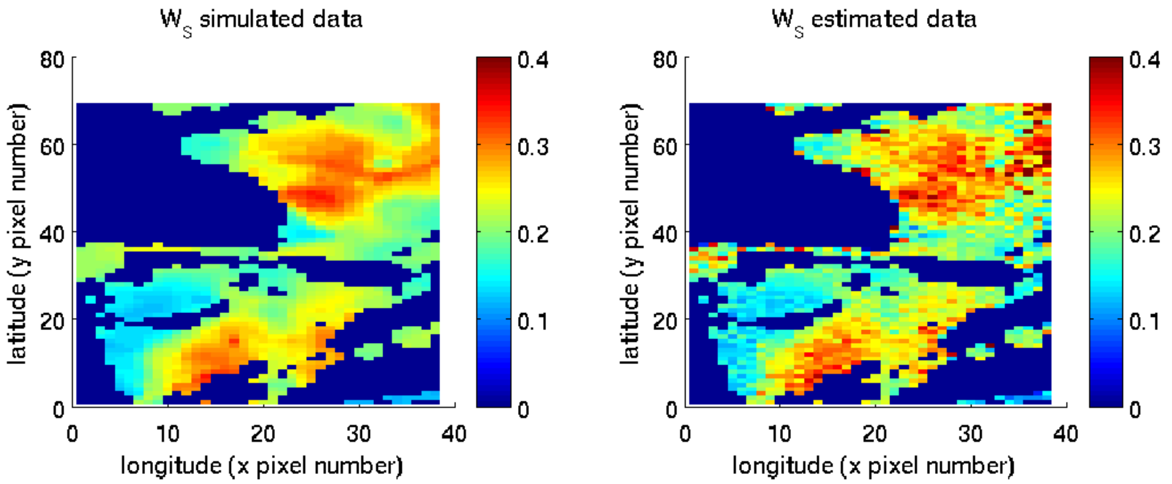
3.2 SMRS

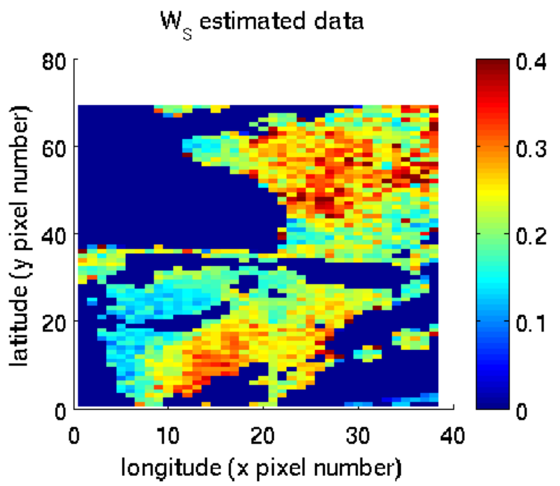
To evaluate the impact of limiting the angular sampling accessible for soil moisture retrieval, we used SMRS, with modified simulated brightness temperature. Because the simulations in SMRS are not concerned with snapshots, the timeliness of the simulation is not representative of what will come out from the instrument. Thus we chose to limit the number of snapshots in a uniform way, for three different experiments: a) small angles limitation, that is supposed to be representative of the impact of calibration occuring at or near the overpass of the satellite. b) large angles limitation, to simulate a calibration event occuring when pixels start to enter the field of view and c) mid range angles, to simulate the general impact of a calibration occuring between the two previous times.

Of course, such a functionality does not exist in SMRS. The solution we selected was to manually remove from the output of the brightness generator module a given number of Tb measurements, at various position in each string, according to the current scenario of calibration impact.

The simulation is once again ran over Europe in summer. Default settings for retrieval options are used as described in [AD2]. This is obviously over pessimistic because all five parameters of the forward model (including surface temperature) are retrieved at once, but we are more interested here in the variations of the performances with the availability of directional samples than in the specific capabilities of the selected algorithm itself.

The first sight is shown in figure below, where the simulated and nominally retrieved soil moisture are in the upper part and the lower part shows the retrieved soil moisture if large angles are removed from the available data set. This is but an example since all kind of ranges can be found missing in the acquisitions.


W$_S$ simulated data
W$_S$ estimated data
latitude (y pixel number)
longitude (x pixel number)
80
60
40
20
0
10
30
0.4
0.3
0.2
0.1

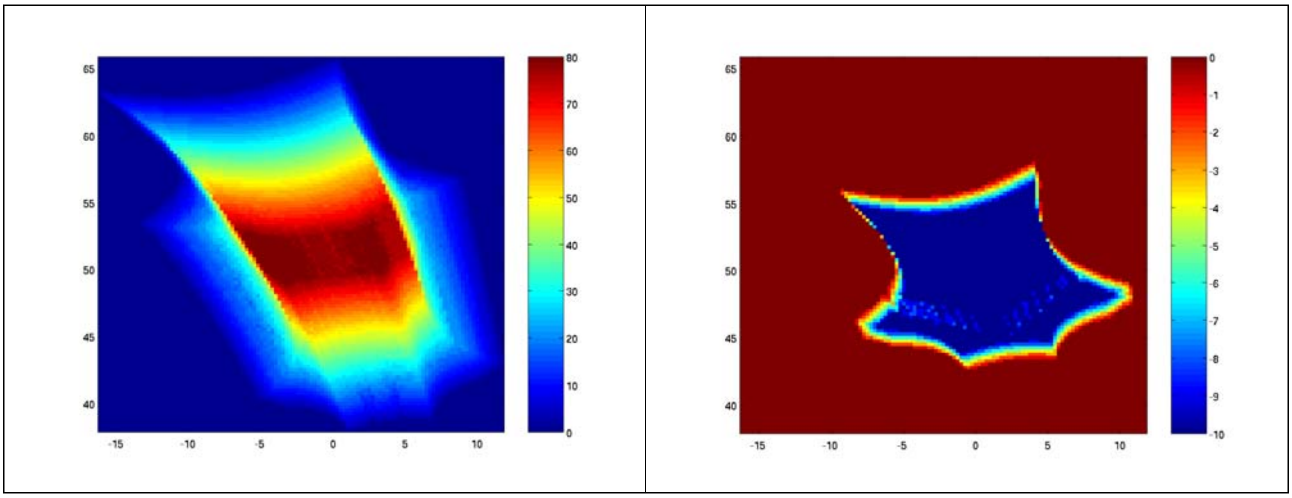

W$_S$ estimated data
latitude (y pixel number)
longitude (x pixel number)
80
60
40
20
0
10
30
0.4
0.3
0.2
0.1

4. RESULTS

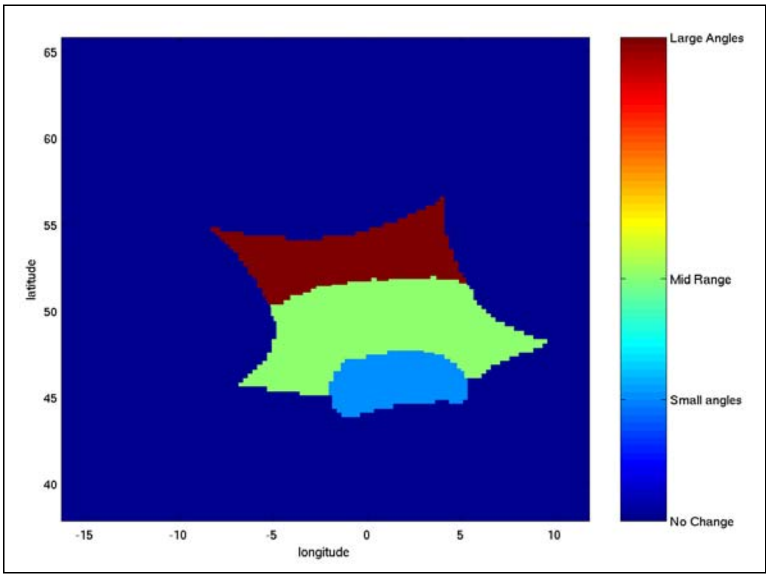
4.1 LEVEL 1

The analysis of SEPS outputs is quite straightforward. We only need to remove from the simulated snapshots the ones acquired during the calibration period.

This has a direct impact in terms of available acquisitions, described in the figure below. Left hand side shows the distribution of acquired data points throughout the swath, and right hand side shows the reduction in data points number due to calibration.



This effect hides a more specific impact: the missing data points limit the available range of incidences according to the following figure:



The classification is as follows:

Small angles $\theta v<25°$ 18%

Mid range $25°< \theta v<50°$ 50%

Large angles $\theta v>50°$ 32%

Out of 4% of time of unavailability

Which shows a map of the areas around the calibration occurrence where view angles are missing and in what range.

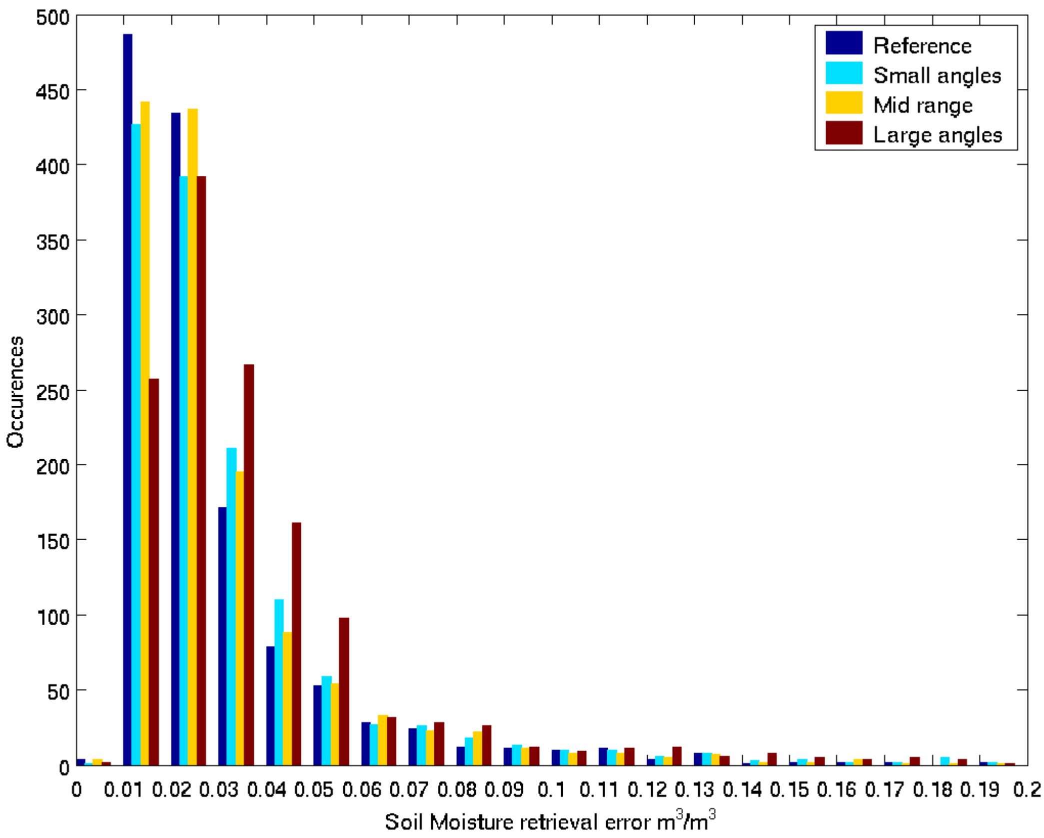
This distribution will allow us to evaluate the impact at level 2, based on the results of the following SMRS simulations.

4.2 LEVEL 2

From the various outputs we can derive statistics of relative degradation of the retrieval performances. They are summarised in the following table:

	Small angles	Mid range	Large angles
Compliant pixel loss	5 %	1 %	16 %
Mean error degradation	0.2 %	0.1 %	0.6 %

Errors vary according to the following distribution:



5. CONCLUSION

A general conclusion can be drawn by combining the preceding results. We make use of the level 1 results to evaluate the surfaces that fall into each category as defined for level 2 analysis. This categorization allows to evaluate more generally what the calibration impact on level 2 products will be.

From the outputs of SEPS simulation and SMRS retrieval, we can estimate the overall loss in compliant pixels at about 6.5% out of 4% of calibration time.

In general terms and as expected, the loss of useful data is somewhat larger than the actual calibration time. This is simply due to the fact that even if data is collected, retrieval will only be good if a sufficient number of view angles, spanning a certain range, is available.

Obviously, this conclusion is only relevant to calibration periods that are short when compared to the dwell line travel time.