Calibration of localization biases for SMOS

François Cabot[1], Yann Kerr[1], Richaume P.[1] and Philippe Waldteufel[2]
(1) CESBIO, 18, Av E Belin 31401 TOULOUSE CEDEX 9 FRANCE
(2) IPSL/SA, 91371 Verrières le Buisson, FRANCE

The Soil Moisture and Ocean Salinity (SMOS) mission [1] aims at observing two variables critical for a large scientific community, from biosphere dynamics to climate monitoring. The mission should also provide information on root zone soil moisture and vegetation and contribute to significant research in the field of the cryosphere.
The original design, 2D interferometric radiometer at L-band, and principle of measurement makes SMOS a challenge at various technical levels. Moreover, stringent requirements on the estimated variables make the complete processing of SMOS data even more challenging.

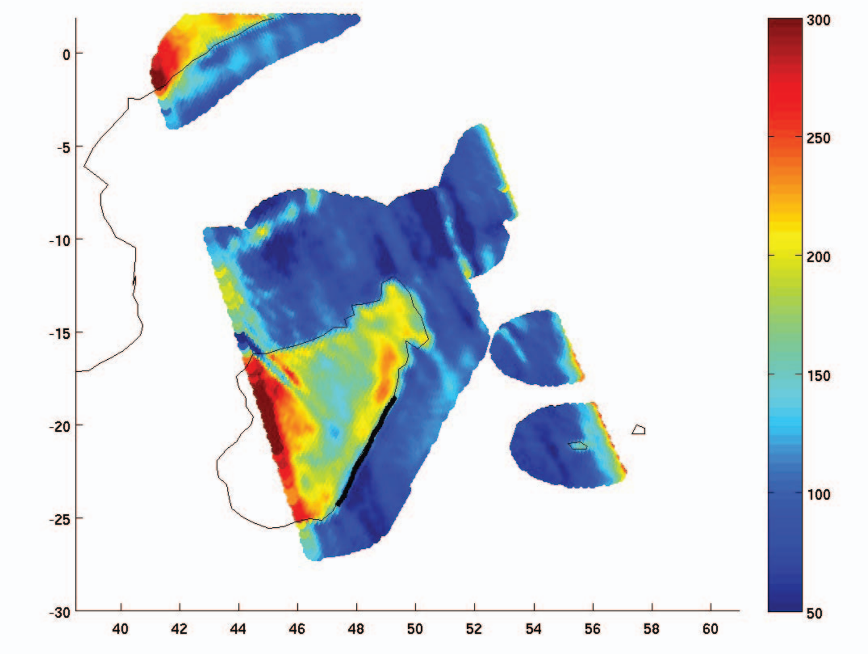
One of these requirements is concerned with the ability to accurately localize all the footprints of the instrument on the surface of the earth. Based on simulation and sensitivity studies with respect to the final retrieval of soil moisture, this accuracy requirement has been established so that the localization error on each footprint presents a zero mean and a standard deviation of 400m. This high accuracy is mainly due to the need for knowledge of open water within a footprint, not to bias soil moisture estimation. This accuracy is highly challenging and unprecedented for sensors of this class and resolution.

The on board devices that will help characterize the geolocation of the SMOS products include stellar sensor and gyroscopes, which can achieve an accuracy consistent with the requirements in terms of standard deviation. But the overall localization budget is also contaminated by an important bias, due to the mechanical deployment of the instrument antenna arms after launch, and to the launch shift that impacts all the alignments on the satellite (mechanical shift of stellar sensor due to shocks and vibrations, moisture desorption in mechanical brackets…).

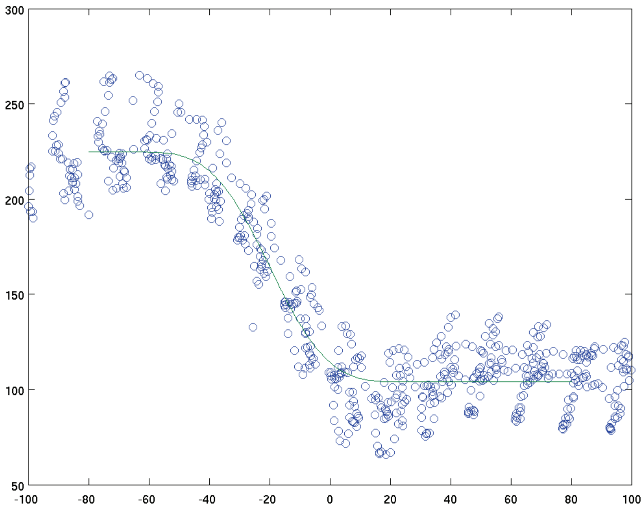
The purpose of this study is to characterize these biases, obviously inaccessible to on ground measurement and expected not to evolve once in orbit, so that they can be accounted for in the ground processing prior to initiate the soil moisture retrieval.
The selected method, as described in [2], is based on the analysis of a large number of views of long linear sharp transitions (coastlines), to maximize the accuracy of measurement in the direction perpendicular to the coast. By analysing alternatively ascending and descending orbits, the complete localization biases can be cornered with a satisfactory accuracy.

After a description of the localization budget and its impact on the soil moisture final products, this presentation will describe the developed method and will present results and accuracy assessment based on the analysis of the first six months of data acquired by SMOS since its launch on November 2nd, 2009.

Figure below shows an example of ascending pass over selected area.



All overpasses are processed to estimate horizontal shift of the coastline. Due to SMOS coarse resolution individual results are very noisy, as can be seen on the example below:



This figure shows the measured brightness temperature in H polarisation across the coastal area, along with the retrieved coastal model, based on a perfect linear coastline and constant sea and earth temperatures.
From all these shift estimates, a corrective attitude matrix is derived, to correct for launch acquired shifts in both roll and pitch direction.

A tentative use of external calibration manoeuvres will also be presented, where the earth horizon can be used as known sharp transition, crossing the field of view as the satellites is rotated to acquire deep space views. Main advantage of this method, beside the simplicity of the geometric model, is to be immune to datation error, that can be misinterpreted as pitch bias in the Madagascar method.

A summary of findings and conclusions about the final localization accuracy for SMOS products will also be given.

References

[1] Kerr Y.H., Waldteufel P., Wigneron J.-P., Martinuzzi J.-M., Font J., and M. Berger, "Soil Moisture Retrieval from Space: The Soil Moisture and Ocean Salinity (SMOS) Mission", IEEE Trans. Geosci. Remote Sensing, vol 39, pp 1729-1735, August 2001.
[2] Cabot F. , Kerr Y. H., and P. Waldteufel, "Calibration of SMOS geolocation biases," Igarss: 2007 Ieee International Geoscience and Remote Sensing Symposium, Vols 1-12 - Sensing and Understanding Our Planet, pp. 4448-4450, 2007.