

# Issues in the Balancing of the SMOS Ocean Salinity Retrieval Cost Function

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## ABSTRACT

The Soil Moisture and Ocean Salinity mission will provide from 2009 onwards sea surface salinity maps over the oceans. In this paper the issues related to the assessment of an optimum configuration of the salinity retrieval cost function will be described.

**Index Terms**— Salinity retrieval, SMOS, Inversion scheme, Cost function, Auxiliary data

## 1. INTRODUCTION

The European Space Agency Soil Moisture and Ocean Salinity (SMOS) mission will be launched on November the 2nd, 2009, to provide synoptic sea surface salinity (SSS) measurements over the oceans with good temporal resolution [1] (Figg. 1 and 2).

The single payload onboard SMOS is the Microwave Imaging Radiometer by Aperture Synthesis (MIRAS), a novel L-band radiometer which measures the brightness temperature ( $T_B$ ) by means of 2-D aperture synthesis interferometry [2].



Fig. 1 The Soil Moisture and Ocean Salinity mission (Credits: ESA - AOES Medialab)



Fig. 2 SMOS just before being encapsulated in the launcher faring (Credits: ESA)

To obtain a proper estimation of the SSS fields derived from MIRAS sensor, a comprehensive inversion procedure has been defined [3].

Nevertheless, several salinity retrieval issues remain critical, and will require maximum attention in the satellite commissioning and operational phase, among them:

- Scene-dependent bias in the radiometric measurements,
- Radiometric errors (associated with thermal noise or imperfect instrument and calibration),
- L-band forward geophysical model function (GMF) definition,
- Auxiliary data, namely sea surface temperature (SST) and wind speed ( $U_{10}$ ), collocation and uncertainties,
- Constraints in the cost function, especially in the salinity term, and
- Adequate spatio-temporal averaging.

These issues will have to be properly addressed in order to meet the proposed accuracy requirement of the mission: a

demanding 0.1 psu (practical salinity unit) after averaging in a 30-day and  $2^\circ \times 2^\circ$  spatio-temporal boxes.

## 2. SALINITY RETREIVAL COST FUNCTION

The salinity retrieval cost function minimizes the difference between the multi-angular measured SMOS  $T_B$ s (yet simulated, so far) and the modelled  $T_B$ s, weighted by the corresponding radiometric noise of the measurements. Furthermore, due to the fact that the minimization problem is both non-linear and ill-posed, background reference terms are needed to nudge the solution and ensuring convergence at the same time [4].

Three constraining terms regarding the SSS, SST and wind speed are considered with their respective uncertainties. Nevertheless, whether SSS constraints have to be included or not as part of the retrieval procedure is still a matter of debate. On one hand, neglecting background reference information on SSS might prevent from retrieving salinity with the prescribed accuracy or at least within reasonable error. Conversely, including constraints in SSS, relying for instance on the climatology, may force the retrieved value to be too close to the reference prior values, thus producing spurious retrievals.

Figure 3 summarizes in a sketched overview the various items involved in the salinity inversion scheme cost function.

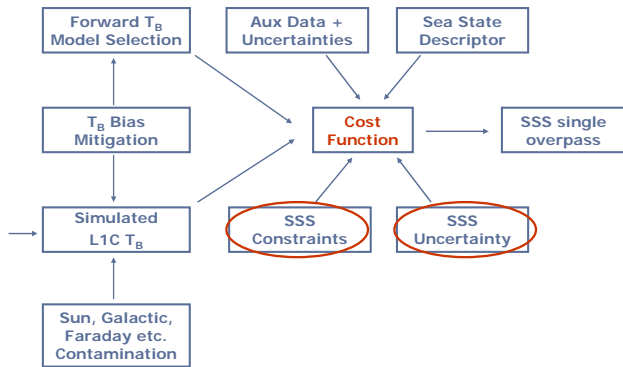
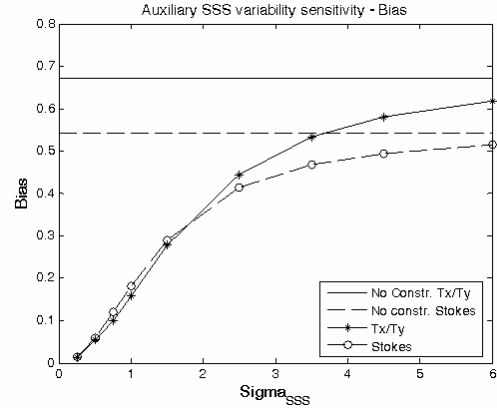
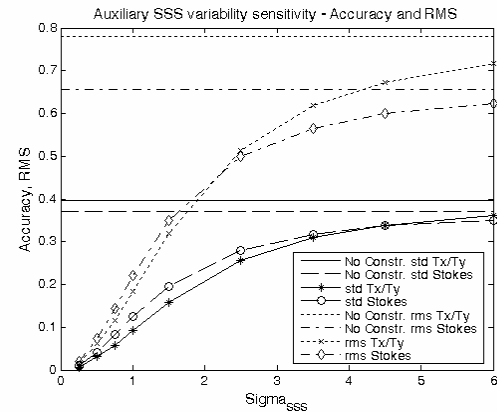


Fig. 3 Salinity retrieval scheme flowchart

In [5] it has been studied the impact of the different auxiliary salinity uncertainties in the accuracy of the retrieval. It has been shown that using physically-consistent salinity field uncertainties of the order of less than 0.5 psu the SSS term turns out to be too constraining. [6]. Figure 4 shows the retrieval performances (bias, accuracy and RMS error) of spatio-temporally averaged salinity fields according to the uncertainty in the value of the auxiliary SSS field.



a)



b)

Fig. 4 Graphical plots illustrating a) mean misfit (bias) and b) accuracies and RMS of a sensitivity study to the auxiliary SSS variability.

## 3. COST FUNCTION BALANCING APPROACH

A half-way solution could be envisaged by using empirical weights which could smooth the overall influence of the SSS term still using the auxiliary fields with their corresponding physically-sounded uncertainties. This operation should be performed for the SST and wind speed term as well.

Simulated data using the SMOS End-to-end Processor Simulator (SEPS), in its full-mode, including the measured antenna patterns for each antenna and all the instrument errors, will be used in this study.

The salinity retrieval process and the SSS maps (for each satellite overpass) are performed with UPC SMOS-Level 2 Processor Simulator (SMOS-L2PS). The relative weight for each of the terms included in the cost function (both observational and background terms) will be assessed in different cost function configurations. Eventually, regularization factors will be introduced to ensure that SMOS information content is fully exploited.

Preliminary results of these experiments will be presented at the conference.

#### 4. ACKNOWLEDGEMENTS

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