Geophysical Research Abstracts,
Vol. 11, EGU2009-10340, 2009
EGU General Assembly 2009

On the Balancing of the SMOS Ocean Salinity Retrieval Cost Function

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The Soil Moisture and Ocean Salinity (SMOS) mission will be launched in mid 2009 to provide synoptic sea surface salinity (SSS) measurements with good temporal resolution [1]. To obtain a proper estimation of the SSS fields derived from the multi-angular brightness temperatures (TB) measured by the Microwave Interferometric Radiometer by Aperture Synthesis (MIRAS) sensor, a comprehensive inversion procedure has been defined [2]. Nevertheless, several salinity retrieval issues remain critical, namely: 1) Scene-dependent bias in the simulated TBs, 2) L-band forward geophysical model function definition, 3) Auxiliary data uncertainties, 4) Constraints in the cost function (inversion), especially in salinity term, and 5) 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 units) after averaging in a 30-day and 2ºx2º spatio-temporal boxes.

The salinity retrieval cost function minimizes the difference between the multi-angular measured SMOS TBs (yet simulated, so far) and the modeled TBs, 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 [3]. Constraining terms in SSS, sea surface temperature (SST) and wind speed are considered with their respective uncertainties.

Moreover, 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.

In [4] 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 (either as the standard deviation of the considered SSS field or as the standard deviation of the misfit between the original and the auxiliary SSS field) the SSS term turns out to be too constraining.

A half-way solution could be envisaged by using empirical weights (regularization factors) 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.

The need for a comprehensive balancing of the different terms included in the cost function is also stressed by recent studies [5], which point out that the even the observational term (TBs) will need to be properly weighted by an effective ratio, taking into account the specific correlation patterns existing in the MIRAS measurements.

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, are 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 (observational and background terms) is assessed in different cost function configurations. Regularization factors are introduced to ensure that SMOS information content is fully exploited. Preliminary results on the cost function balancing will be shown at the conference.

References

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