

SMOS: ESA'S WATER MISSION

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ESA's Water Mission, otherwise known as the Soil Moisture and Ocean Salinity Mission (SMOS) was selected as the second Earth Explorer opportunity mission to be implemented and is expected for launch in July 2009. SMOS single payload, an interferometric microwave radiometer, shall provide global observations of soil moisture and ocean salinity to improve our understanding of the Earth's hydrological cycle.

One of the highest priorities in Earth science and environmental policy issues confronting society today is to understand the potential consequences resulting from modification of the Earth's water cycle due to climate change. The influence of increases in atmospheric greenhouse gases and aerosols on atmospheric water vapour concentrations, clouds, precipitation patterns and water availability must be understood in order to predict the consequences for water availability for consumption and agriculture.

In a warmer climate, increased evaporation may well accelerate the hydrologic

cycle, resulting in changes in the patterns of evaporation over the ocean and land and an increase in the amount of moisture circulating through the atmosphere. Many uncertainties remain, however, as illustrated by the inconsistent results given by current numerical weather and climate prediction models regarding the future distribution of precipitation.

It is evident that insufficient data are available today to help improve our scientific knowledge and understanding of the processes influencing the water cycle. Thus, ESA, the French Space Agency (CNES) and Spanish Centre for Development of Industrial Technology CDTI have teamed up to address this key scientific challenge by delivering a fundamentally new satellite tool to realise these new global datasets. The resulting regular, consistent measurement data will be used to improve our understanding of the way in which both the time-varying distribution of soil moisture and ocean salinity regulate the water cycle of our Blue Planet.

ISSUES IN 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 late 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, among them: 1) Scene-dependent bias in the simulated TBs, 2) Lband forward geophysical model function definition, 3) Auxiliary data collocation and uncertainties, 4) Constraints in the cost function (inversion), especially in salinity term. 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 2°x2° 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 the SSS

term turns out to be too constraining. 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, 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.

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