MEDITERRANEAN SEA SURFACE SALINITY MEASURED FROM SMOS

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Abstract
The Soil Moisture and Ocean Salinity (SMOS) mission is an innovative Earth Observation satellite launched on November 2009 to remotely sense soil moisture over land and sea surface salinity over the oceans [1,2]. Due to some limitations with the processing technology, SMOS SSS maps still displayed significant artifacts and biases that until now prevented to retrieve SSS in the Mediterranean. In this work new techniques (calibration techniques [3]; image reconstruction methods [4, 5]; SSS retrieval algorithms [6]; and fusion schemes [7]) have been applied, allowing us to compute SMOS SSS maps in the Mediterranean for the first time. In this work we present these new SMOS SSS maps and we provide an assessment of their quality by means of their comparison with Argo buoys and SSS measurements obtained in several campaigns [8].

Keywords: Mediterranean Sea, Salinity, Remote sensing

After more than six years of mission, the retrieval of the Mediterranean Sea Surface Salinity (SSS) using the measurements by the satellite Soil Moisture and Ocean Salinity (SMOS) mission had not been possible. Many instrumental error patterns, as Land-Sea Contamination (LSC), seasonal biases, differences between ascending and descending orbits, systematic sources of Radio Frequency Interference (RFI), etc. [7,8], made impossible the computation of SSS in the Mediterranean. Recently, a study on LSC has shown that the correlator efficiency errors are the main driver of this contamination and a simple correction scheme has been proposed to mitigate it [1]. On the other hand, a novel image reconstruction technique, the Nodal Sampling [2], has been introduced to reduce tails and ripples (the so-called Gibbs-like contaminationm produced by land/sea/ice transitions and RFI sources). In this work we have used these two techniques together. So, the correction proposed in [1] has been applied prior to the image reconstruction by nodal sampling technique. The resulting Brightness Temperatures (TB) are in better agreement with the modeled ones [3].

A non-Bayesian approach is used for retrieving SSS from the improved TB [4]. In this approach, one SSS is directly retrieved for each TB measurement. On one hand, this retrieval methodology allows a better characterization of the systematic biases and therefore a proper correction of such patterns. On the other hand, new filtering criteria based on the statistical properties of sets of SSS that have been retrieved under the same orbital conditions along six years of SMOS mission, allow us providing measurements in areas where SMOS could not provide information until now. Finally, the time and space resolution of the SSS maps have been improved by using the Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA) Sea Surface Temperature (SST) maps [9]. We have used the methodology proposed in [5], which starting from some established principles of horizontal turbulence shows that the gradients of both SSS and SST can be related by a smooth matrix (a composition of a rotation and a scale factor), and that matrix can be estimated from the data themselves.

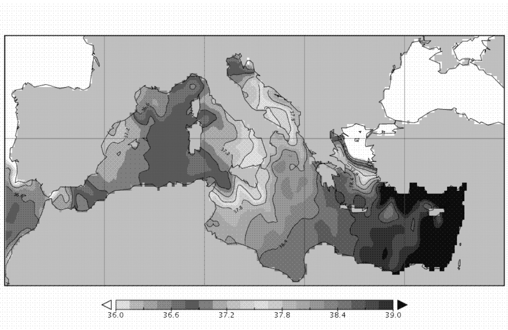

Fig. 1. SMOS Salinity map for the 10th of September of 2012

We have generated five years (2011-2015) of daily maps. Figure 1 shows the SMOS SSS map for the 10th of September of 2012. Three different sources of data have been used for assessing the quality of these new maps. First, the SMOS salinity maps have been compared with the Mediterranean Sea Physics Analysis and forecast provided by Copernicus [10]. Second, in situ data from close-to-surface acquisitions by Argo floats (freely distributed by the CORIOLIS data center, http://www.coriolis.eu.org) have been used for computing statistical information of the differences between the remote sensed and in situ measured salinities. Third, measurements of the thermosalinometers (TRANSMED [6]) and opportunity ships have been used for assessing the capability of SMOS for monitoring the salinity dynamics and capturing the mesoscale in the Mediterranean.

Although there are some pending issues, the new SMOS salinity maps in the Mediterranean attain a reasonable quality and are able of capturing the main SSS signature.

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