Comparison between the SMOS l2 vegetation optical depth product over low vegetation and vegetation indices and leaf area index during 2010-2011

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Heather Lawrence[1,2], Jean-Pierre Wigneron[3], Nathalie Novello[3], Philippe Richaume[2], Ernesto Lopez-Baeza[1], Delphine Leroux[2], Arnaud Mialon[2], Jennifer Grant[4], Maciej Miernecki[1], Christophe Moisy[3], and Yann Kerr[2]

1. Department of Physics of the Earth and Thermodynamics, University of Valencia, Spain

2. Centre d'Etudes Spatiales de la BIOsphère (CESBIO) Toulouse, France

E-mail: heather.lawrence@cesbio.cnes.fr

3. Institut National de la Recherche Agronomique (INRA) Bordeaux, France

4. ESA/ESTEC, Noordwijk, The Netherlands

The Soil Moisture and Ocean Salinity (SMOS) mission [1] was successfully launched in November 2009 and is the first mission dedicated to providing global surface soil moisture fields at a high temporal resolution of three days. The satellite carries a 1.4 GHz (L-band) interferometric radiometer which measures the brightness temperature at angles from 0° to $50-55°$ and at polarizations X and Y, which are in the antenna frame. From these measurements we can derive brightness temperatures at H and V polarization, for all measured angles. A forward inversion algorithm, using the so-called L-band Microwave Emission of the Biosphere (L-MEB) model, is used to retrieve simultaneously land surface soil moisture content (SM) and vegetation optical depth (TAU) from brightness temperature measurements.

Since the launch of SMOS, the scientific team has worked to assess the quality of these data products. Thus far, this has been done by comparing the temporal evolution of brightness temperatures and the Level 2 (L2) land products, SM and TAU, with in-situ data and remotely sensed vegetation indices estimated in the optical domain. These evaluations have been carried out over various sites representative of some of the most widespread biomes of the globe, including semi-arid areas in western Africa [2], continental US areas using the SCAN/SNOTEL soil moisture monitoring network [3], low vegetation on the VAS site in Valencia, Spain [4], forests [5], and south-eastern Australia [6].

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An advantage of the SMOS mission when compared to other space missions (e.g. AMSR-E, SMAP) is that the vegetation optical depth, TAU, does not have to be estimated but is retrieved simultaneously to SM. The value of TAU provides information on the vegetation water content and biomass and on the vegetation dynamic [7], [8]. In this study the SMOS retrieved L2 TAU product is compared to remotely sensed Vegetation Indices (VIs) and Leaf Area Index (LAI) values from the MODIS satellite sensor. The aim of this study was firstly to assess the SMOS TAU product on a global scale, by observing temporal patterns, and secondly to investigate the relationship between TAU and vegetation properties, by studying the correlation between TAU and remotely sensed vegetation parameters retrieved in the optical domain, including LAI, Normalised Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index (EVI).

The study presented here was performed for two years of data, from 2010 to 2011. Firstly SMOS study areas (DGG points) were selected based on the criteria that a) soil moisture and TAU retrievals were achieved, and b) the fraction of low vegetation cover, as defined in the SMOS algorithm, was greater than 95 %. This meant that all areas included in the study could be considered to be homogeneous low vegetation, as viewed by SMOS. In addition SMOS calibration/validation sites, where ground measurements were available were included, notably the Valencia Anchor Station (VAS), where vegetation properties have been studied [9], and sites in the COSMOS network [10]. Retrieved values of TAU were only considered when the selected areas fell in the centre of the SMOS swath. This was because we expect a higher retrieval accuracy for the centre of the swath, due to there being more angles available for the retrieval and a lower estimated error in brightness temperatures.

Vegetation indices were taken from MODIS synthetic products and included NDVI, EVI and LAI, which have a time resolution of approximately 16 days for NDVI and EVI and 4-8 days for LAI. In order to compare the retrieved TAU with vegetation indices, a VI product that could be compared directly to SMOS data was first calculated. The MODIS VI products have a 1km resolution wheareas in the SMOS retrieval algorithm input parameters are projected onto a grid of 4km resolution (the Discrete Fine Flexible Grid or DFFG). Therefore the VIs were first averaged to create aggregated VI values at a 4km resolution. Secondly the aggregated VIs were multiplied by the SMOS mean antenna weighting function (mean WEF) and values summed. This created an average VI for each study area (SMOS DGG point), where VI values in the centre of the SMOS field of view were weighted more strongly, and values at the edge of the field of view more weakly.

Retrieved SMOS TAU values were then compared to weighted VI values over the selected homogeneous low-vegetation study areas for the whole of 2010 and 2011. This allowed us to assess whether there were significant correlations and for what conditions they occurred. We also assessed which of the three indices provided the best correlations for each low vegetation type. This provided interesting results which allowed us to suggest improvements to the SMOS algorithm for areas where

TAU cannot be retrieved (usually the edges of the swath where there are not enough angles for a 2-parameter retrieval, or in mixed pixels) and also suggest new values of TAU to be used in future space missions where a two-parameter retrieval is not possible, such as the upcoming SMAP mission.

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