SMOS retrievals of vegetation optical depth over a variety of land use: trials and tribulations

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1. INTRODUCTION

The SMOS mission [1-2] was launched in November 2009 and allows measuring the surface soil moisture over continental land, covering the entire surface in 3 days. The multi-angular algorithm also enables to estimate the vegetation opacity which is directly related to the water content of the canopy. The algorithm also distinguishes between low vegetation where most of the signal emanates from the leaf and stems of the vegetation and the forests where the signal is mainly linked to the branch biomass at L band. ESA's DPGS (European Space Agency's Data Processing Ground Segment) has been delivering the so called Level 2 products, consisting in ½ orbits data for both products since launch [3-4].

The CNES (Centre National d'Etudes Spatiales) has developed the CATDS (Centre Aval de Traitement des Données SMOS) ground segment that now provides spatial and temporal synthesis products (referred to as Level 3 products) enabling to better estimate the vegetation opacity (as well as soil moisture and brightness temperature over land)[5].

After now several years of availability , the soil moisture product is rather robust but the vegetation opacity, either obtained at level 2 or 3 still suffers from several flaws, even if it looks promising.

In this paper we will look at the products and how they are obtained as well as the main results obtained over both low vegetation and forested areas.

2. DATA SETS

We have used two data sets one from the SMOS level 2 and the other from level 3 as shown on figure 1 and depicted in table 1.Other data sets are used to compute the retrievals as explained in [3-5]

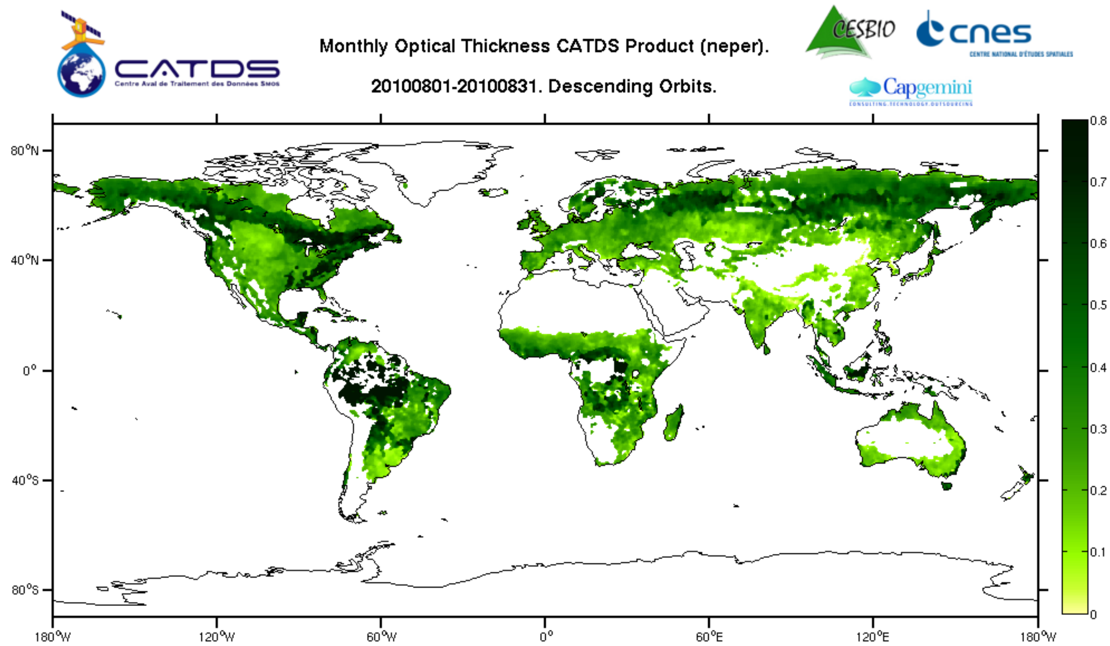

Figure 1 Vegetation optical depth for August 2010 (Level 3 product)

3. METHODOLOGY

The approaches are fully described in references [3-5] and are based on the L-MEB model [6]. For instance, first results obtained in the central plain of the USA evaluated the link between opacity and vegetation indices (NDVI, LAI, NDWI). In particular the study confirmed the linear relationship used in the algorithm: TAU = b' LAI + b''; with b' = 0.06.

Over forested areas the basic algorithm [7] was improved on several occasions, the most advanced running in version 600 of the level 2 algorithm and described in [8]. A global map is shown on figure 2. We can clearly see the different large forest bodies in either the high latitude areas or in the tropical regions. The results were validated against a set of ground sites but the only real conclusive result was obtained with the comparison with Icesat vegetation height estimates [8].

Table 1 – Overview of SMOS VOD data sets.

	Level 2 low vegetation	Level 2 Forest	Level 3 Low vegetation	Level 3 forest
Reference	[3]	[8]	[5]	[4]
Product sampling	15 km	15 km	25 km	25 km
Algorithm base	τ, ω	τ,ω	τ, ω	τ, ω
Approach	Current files		Multi orbit	
Uses	parameters	LAI max	Parameters	LAI max

4. RESULTS AND DISCUSSION

If over forest the results do look very satisfactory it is obvious that validation is somewhat difficult as very few ground datasets are available. To circumvent this issue we have performed several validation exercises. They are based either on the relationship between canopy height (from IceSAT) which is assumed to be proportional – per forest type - to the branch volume and hence opacity or on the accuracy of the Soil moisture estimate under the canopy. For the latter we used the available datasets and in particular the Scan Snotel networks [9] using soil moisture as an indicator of accuracy.

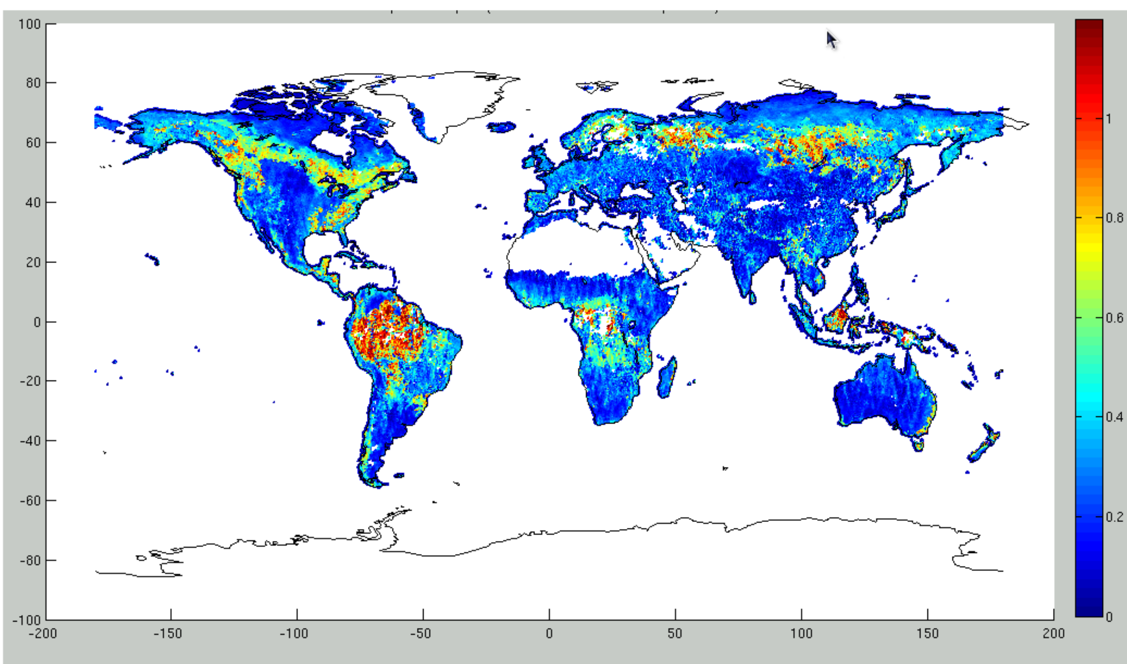

Figure 2 Vegetation opacities retrieved with new algorithm over forested areas (and routine algorithm over low vegetation)

For low vegetation results were more difficult to access as the retrieved vegetation opacities tend to be extremely noisy. A large part of the noise is linked to either low level Radio frequency interferences or to calibration errors. Version 600 of the level 1 algorithm improves significantly the calibration and spatial calibration errors of level 1 and thus it is expected that the retrievals will be improved. Moreover a number of studies are currently analyzing the modelling itself and further improvements are expected (in particular with respect to the roughness opacity coupling).

5. CONCLUSION AND PERSPECTIVES

The new version 600 available early 2014 should provide a significant improvement on vegetation opacity retrievals for both forest and low vegetation. It is however expected that some issues will remain linked to inaccuracies in the land cover classification errors or roughness poor estimates. To circumvent these issues, novel studies are being initiated including the use of a two stream approach rather than the 0^{th} order scattering model currently used. It is also considered to develop a specific, vegetation centered, vegetation retrieval scheme.

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