MULTI-ORBIT INVERSION OF SMOS SURFACE SOIL MOISTURE

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1. INTRODUCTION

Following its successful launch on November 2 2009, Soil Moisture and Ocean Salinity (SMOS) [1] mission is undergoing commissioning phase. SMOS is European Space Agency (ESA)'s second Earth Explorer Opportunity in collaboration with Centre National d'Etudes Spatiales (CNES) in France and the Centro para el Desarrollo Teccnologico Industrial (CDTI) in Spain. SMOS mission will deliver surface soil moisture (over 5 cm) and surface ocean salinity (< 1 cm) obtained from observations by an L-band 2D interferometric radiometer. SMOS will achieve a spatial resolution of 50 km at L-band (43 km on average) with a 0.04 m^3/m^3 error on nominal scenes. Soil moisture is a key interface parameter controlling the exchanges between the continental surfaces and the atmosphere, and the surface/ subsurface flows. CNES has devoted a post-processing center, Centre Aval de Traitement des données SMOS (CATDS), to produce and disseminate level 3 and 4 products for SMOS. In this paper we present the enhanced soil moisture retrieval algorithm (L3SM) that will be implemented at CATDS. We focus on the use of multi-orbit inversion.

2. MULTI-ORBIT INVERSION

The L3SM multi-orbit is based on the level 2 SM processor [2]. The main objective of these retrievals is to obtain soil moisture estimations from multi-angular brightness temperature observations and ancillary data (LAI, ECMWF). The brightness temperatures are obtained at level 1 processing by reconstruction of passive L-Band visibilities. The L2SM is based on the L-band Microwave Emission of the Biosphere model (L-MEB) [2] to model the surface emissivities. Surface contributions are computed on each node of a discrete global grid and for each type of cover (18 classes) taking into consideration a 125×125 km^2 area that covers the angular dependant antenna weighting function. An iterative optimization algorithm in then used to retrieve surface geophysical parameters mainly soil moisture by minimizing a cost function. The cost function represents the quadratic difference between modeled and measured brightness temperatures for different incidence angles normalized by their relative uncertainties. The free (optimized) parameters in the retrieval are associated with the dominant surface only; all other surfaces have default contributions to the emissivities. The dominant surface is determined from the convolution of the mean weighting function of the antenna by the land cover map at higher resolution (4 km).

At level 2 soil moisture retrievals will be constrained by the use of optical thickness initialization maps (current files) obtained from previous inversions and continuously updated. By the use in the inversion of initialization maps, associated with low uncertainties, the compensation effect between soil moisture and optical thickness is reduced. Thus from the use of this a priori information better products are expected.

One of the major enhancements at level 3 soil moisture retrievals is the use of multi-orbit soil moisture inversion. This inversion will be applied to nominal (bare soil, low vegetation) scenes with stable climatic conditions (no dew, snow or freeze conditions). The multi-orbit inversion will be highly advantageous on the edges of the Extended Alias Field Of View (EAFOV) where the range (42°- 46°) and number of samples (25) of incidence angels is reduced (see figure 1). The complementary orbits used in the inversion will greatly enhance the angular sampling and range. The algorithm will make use of the re-visit frequency of SMOS (3 days maximum) and of the high temporal correlation of optical thickness. In fact, though surface soil moisture can change from saturated conditions to dry conditions in a 3 days interval and vice versa, optical thickness present a more stable behavior for long parts of the year (at least for a 3 days interval) at 40 km resolution. As explained above, correlation will be applied only where optical thickness correlation can be guaranteed. Prior to inversion complementary revisits will be chosen from a several days time series.

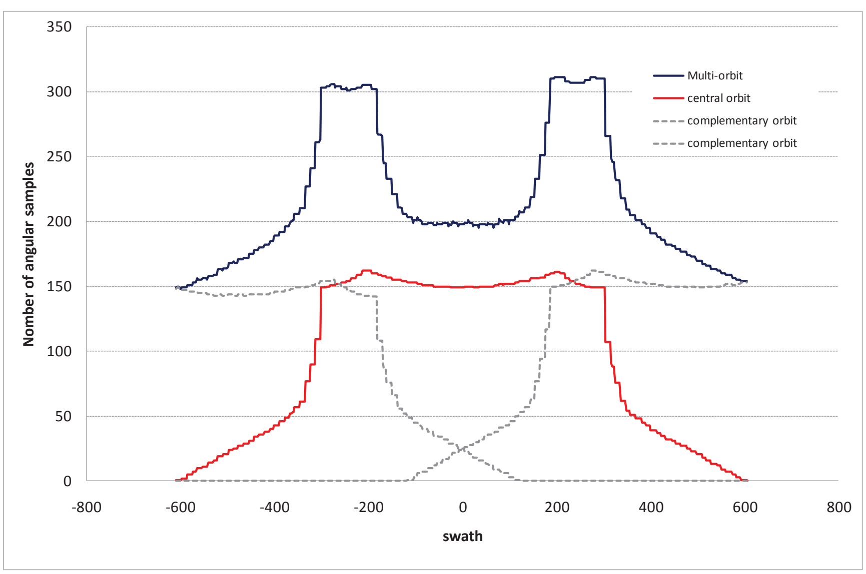

Figure1 – Number of angular samples without quality filtering for the mono orbit inversion (red), the multi-orbit inversion (bleu), and the complementary orbits (dashed grey).

3. BENEFIT OF MULTI-ORBIT INVERSION

The benefit from the use of multi-orbit inversion will be presented with emphasis on soil moisture enhancement in terms of quality and number of successful retrievals. The multi-orbit inversion is compared to mono-orbit inversion with or without use of initialization (current) maps. Comparison is made using two datasets: a synthetic dataset and a realistic dataset. The synthetic surface is generated in order to inspect the benefit of the method with controlled time varying conditions. The synthetic surface contains a large range of SM values and optical thicknesses with changing weather conditions. The surfaces can be also classified as homogeneous and heterogeneous. The homogeneous surfaces are used to assess the theoretical validity of the method. The ensemble of possible combinations enables a sensibility analysis of the method. The realistic dataset is based on data from regions across Europe.

4. REFERENCES

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