Mapping surface soil moisture over the Gourma mesoscale site (Mali) by using ENVISAT ASAR data.

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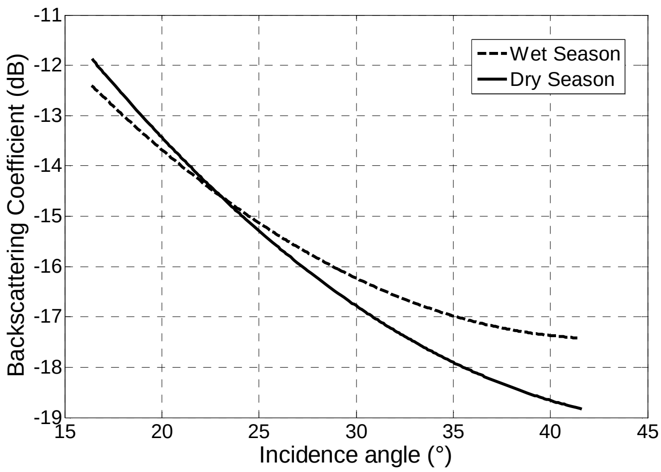
Response to the reviewers'#1 comments

1. This method allows taking into account the seasonal vegetation effect on the angular variation of the backscattered coefficient. In this case, two normalization functions depending on the season are used. For the dry season (from January to May and from October to December), which is when the green vegetation cover is small or absent. For the wet season, a simple normalization function is built by considering all of the ASAR data recorded at the date of maximum green vegetation cover. The following figure illustrates the angular dependency of the radar signal during the dry (no vegetation) and the wet seasons (maximum of vegetation). The wet regression is estimated from a radar image acquired in September (DoY 248), when soil surface is getting drier and green vegetation is closed to its maximum (DoY 232). The resulting angular functions show that the effect of the vegetation layer has to be taken into account in the normalization procedure.



Angular variations of the HH backscattering coefficient during the dry and wet seasons for the sand dune landscape estimated for the 2005 dry period and on DoY 248.

This angular normalisation function has been presented in previous papers (see Baup et al., 2007a and b). So, we simply add a short description of the normalisation method in the proposed paper.

2. As you mentioned, the term 'change detection method' is not exact and has been removed from the text.

3. This point has been clarified in chapter 2.4, part 5: "Finally, *SSM* maps are estimated at kilometric scale from the difference between dry images acquired respectively between the dry and the wet seasons over the mesoscale window by applying empirical inversion

functions estimated for sandy and rocky soils. Coefficients of these linear functions are given in Table 4”.

For best clarity, a radiometric normalization step has been inserted in figure 5 and rephrasing as follows in the section 2.4 (Methodology of surface soil moisture mapping)**:**

“ The radiometric correction step consists in processing the difference between one dry season image chosen as a reference and the wet season image of interest (IOI)) “

4. Following the reviewer’s suggestion, the modifications have been done.

5. As mentioned by the reviewer, there is not enough data to conclude of any statistical relationship for the Bamba site. It was the reason why coefficients of the regression functions were so different between the different study sites. Accordingly, the Bamba site has thus been removed from the analysis.

The other regression functions were estimated using all the available images (not only one image), so coefficients are now more consistent.

Following the reviewer suggestion, a new figure was added showing the relationships between the backscattering coefficient and the surface soil moisture for the three sites under consideration, i.e. the two sandy sites and the rocky site. In addition, the general regression function used for sandy sites has also been added.

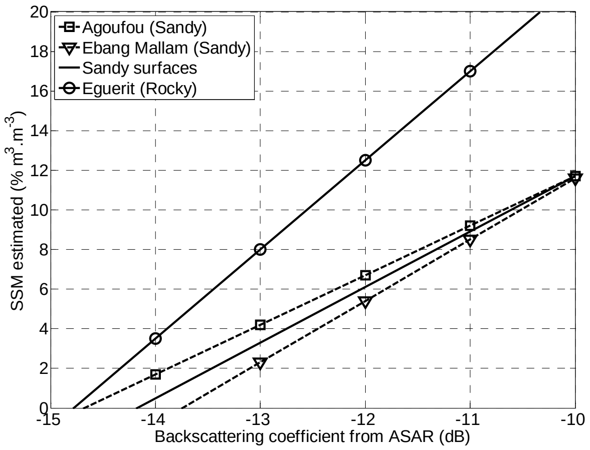


Fig 7: Backscattering coefficient– Surface Soil Moisture regression functions estimated over the two sandy sites and the rocky site. The final regression function used over sandy surfaces is also plotted.

6. The definition of $\alpha_{INITIAL}$ and α_{NORM} have been inserted in the legend of Figure 5 to improve its clarity. SSM functions are detailed in Table 4. A reference to Table 4 have been inserted in the chapter 2.4 : **"**Methodology of surface soil moisture mapping".

7. The bias observed between ASAR and WSC SSM products comes from the method used to estimate SSM from WSC data (see Zribi et al., 2008). As already noticed over similar semi-arid surfaces by Gruhier et al. (2010), WSC SSM products generally overestimate SSM during the wet and dry seasons (see figure below)):

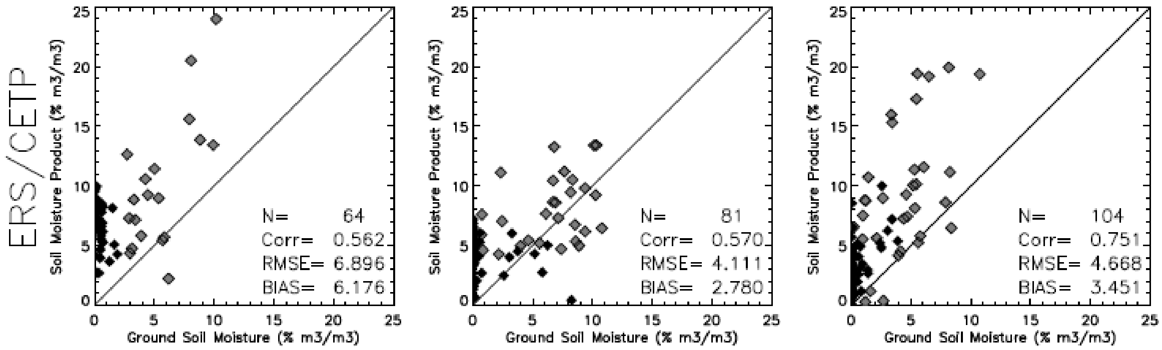
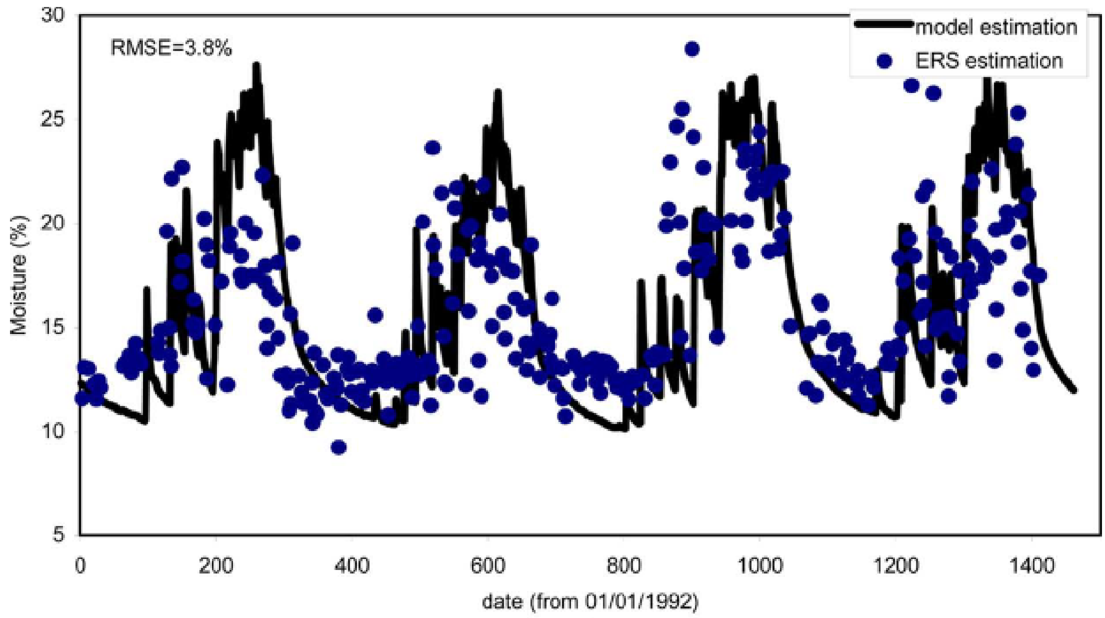
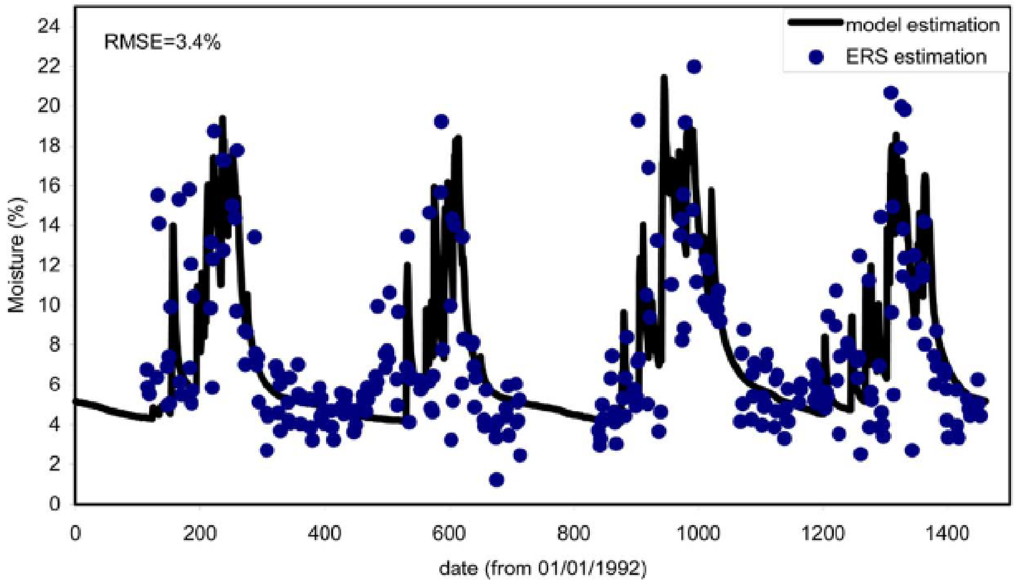


Fig. 11. Soil moisture from products versus from ground measurements. Black points correspond to dry seasons (October to June) and grey points to monsoon seasons (July-August-September). Statistical results shown are calculated during two years period.

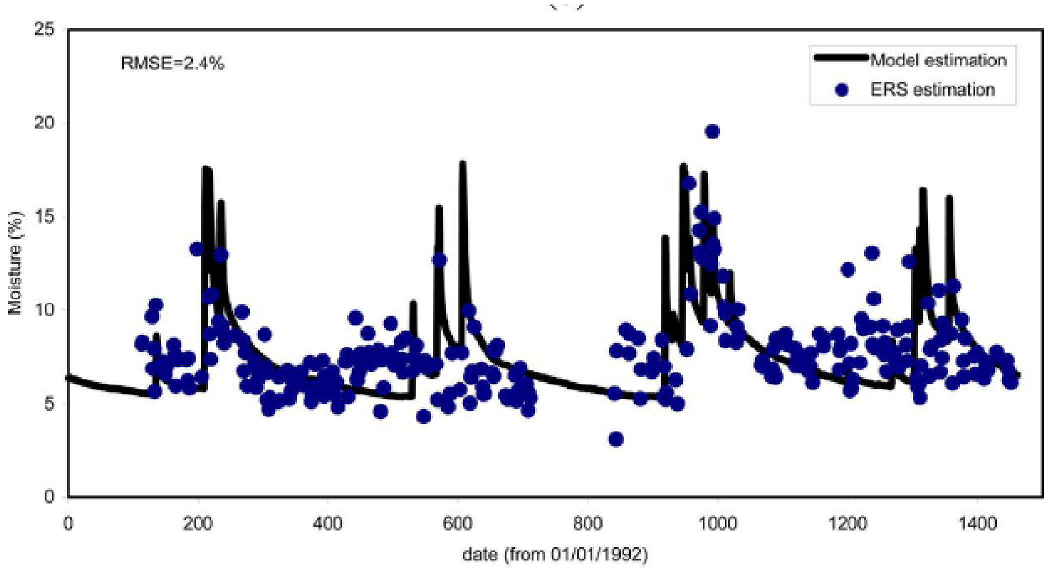
Zribi et al., 2008 also show that SSM changes are not significant under 10% and are generally noisy during the dry season, whatever the considered study site in West Africa, represented by Sahel or desert regions on the following figure (b and c).



(a)



(b)



(c)

Fig. 7. Comparison between GSWP-2 model outputs and our soil moisture estimations for three regions. (a) Tropical region (10°–3°). (b) Sahel region (13°–3°). (c) Desert region (16°–3°).

The analysis of ASAR backscattering signal has been splitted into dry and wet seasons to characterize respectively the noise (with an amplitude varying from 3 to 10%) and the variations of the signal caused by *SSM* changes (with an amplitude varying from 10 to 20%).

No comparison between local and browse WSC SSM are performed because of the coarse resolution of this product (~25 km).

As suggested by the reviewer, comments on figure 11 have been more detailed at the end of the paragraph 4 to improve its clarity.