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Interactive comment on "Soil parameters estimation over bare agriculture areas from C-band polarimetric SAR data using neural networks" *by* N. Baghdadi et al.

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Comments on the paper: "Soil parameters estimation over bare agriculture areas from C-band polarimetric SAR data using neural networks".

This paper has the purpose to estimate soil moisture and soil roughness from RADARSAT-2 data by using a MLP neural network (NN) trained with data simulated by IEM with a wide range of soil moisture, soil roughness and incidence angle. The study has investigated the retrieval performances as a function of the noise level added to theoretical data and the improvements that the use of a priori-information on soil moisture and/or soil roughness can produce. Then, the NN method has been applied to

RADARSAT-2 data acquired over experimental areas. Although this work is interesting for the topic and for the processing of real RADARSAT-2 data, the method employed, the use of the a priori information and the retrieval accuracy obtained for the parameters do not represent a significant innovative contribute with respect to material presented in similar works already published on this topic.

For these reasons, the paper should be reviewed before accepting it for publication. In particular, I find that next points from 1 to 6 should be further discussed.

1) On the retrieval method.

1.a) In my opinion the potential of NN for soil moisture estimation has been already investigated in literature (other papers could be mentioned at page 2900, line 21). In fact, the use of neural networks to retrieve soil moisture from SAR data has been proposed in a number of papers (as the cited works of Dawson et al.(1997), Notarnicola et al.(2008), Satalino et al.(2002), and so on), which show the application of NNs to C band (or other) SAR data without and/or with a priori information. Anyway, a part the well known advantages of using NN, the intrinsic limit of this method in estimating soil parameters is that the retrieval accuracy is related to complexity of the ill-posed problem (i.e. a problem with multiple solutions). In fact, the neural network, approximating the inverse of the IEM model, can provide for each (single/multiple polarized backscatter) input, only one solution among all possible solutions. It is expected that a NN trained by minimizing the Means Square Error criteria, gives as a solution the most probable solution, or in other terms, the average of all possible solutions (Bishop C.M., "Neural Networks for Pattern Recognition", Clarendon Press – Oxford, 1995). As a consequence, the expected error of this method depends on the dispersion of all possible solutions, and this dispersion is related to the range of soil parameters used to simulate SAR data by IEM. It happens that the narrower the range of soil parameters is, the more accurate the parameter retrieval is. As a consequence, all the papers facing the soil moisture retrieval from SAR data by using NN, as this study do, focus the investigations on an effective exploitation of a priori information rather than on the the

use of NN, that could be considered a standard method. Are there other motivations that suggested to authors to use NN instead of other methods?

2) On the synthetic data set. The training and testing data set were obtained by running IEM with the range of input parameters shown in Sect. 2.1.

2.a) if range of rms for HV is [0.5cm, 3.6cm] and that for HH and VV is [0.3cm, 5cm], I infer that the joint range for all co- and cross-polarizations should be [0.5cm, 3.6cm]. Why simulated data were generated by using the range [0.3cm, 5cm] (Page 2902, line 22)?

2.b) Previous studies dedicated to the retrieval of soil moisture and soil roughness usually use single or double co-polarized (HH or VV or HH and VV) SAR data. Why authors propose to invert also HV? Could they report the last theoretical results in literature which state that the simulated cross-pol by using IEM are reliable and can be exploited in the soil moisture retrieval? Moreover, at page 2899, line 20 it is stated that the soil moisture retrieval accuracy does not improve significantly when two polarizations (HV and HH, C-band) are used instead of only one polarization (Baghdadi et al.,2006a). Why in this case, the (calibrated) cross-pol is employed? At this point is necessary to evaluate how much the results changes using or not HV data.

2.c) L_opt equations were set by using other SAR data set obtaining high coefficient of determination (Page 2902, line 13 and line 16). Considering the availability of RADARSAT-2 experimental data, could author report the discrepancy between the calibrated theoretical backscatters and experimental backscatters?

3) On the a priori information. A priori information on soil moisture and soil roughness were used to simulate dry and wet data, smooth and rough data, respectively, as reported in Sect. 2.4, case 2 and case 3. The a priori information on soil moisture and soil roughness is obtained from the alpha and anisotropy parameters extracted from data.

3.a) At page 2906, the overlap for the soil moisture variable between dry and wet data set is 0.10 cm_3 cm_-3 (not 0.05), whereas the overlap for the soil roughness variable between smooth and rough data should be 1 cm (not 0.5).

4) On the evaluation of the synthetic data set.

4.a) Page 2908, line 23: Fig. 2 and Fig. 3 should represent results for a given rms between 0.5cm and 3.6cm (instead of between 1.0cm and 3.6cm). Moreover, Figures can not be well appreciated. It could be better showing only one case (for example the case 3-a priori information on Mv), commenting the box dimensions, bars over the boxes, the distribution of the red signs.

5) On the evaluation of the real data set.

5.a) Table 3: It is not clear why results with 1.0dB of noise are better than results with 0.5dB of noise. Probably because RADARSAT-2 has a noise closer to 1.0dB, as stated. Could it be also due to a mismatch of calibrated theoretical backscatters used to train the NN and these experimental data? Again it is important to understand point 2.c).

5.b) How much reliable is the a priori information derived from alpha and anisotropy parameters? An indicator could be simply the RMSE computed with respect to these starting values.

5.c) Table 3, Fig. 4 and Fig. 5: have the results been obtained by using NNs trained with data generated at incidence angles of 35° and 45°? If yes, could author confirm that simulated data at incidence within the range [25°, 35°] and [35°, 45°] (with step 2.5°) were not used for training and testing ?

6) On the retrieval accuracy.

6.a) Which user requirements, in terms of the accuracy of soil moisture content estimates, should be satisfied for a useful employment if soil moisture maps in hydrologic or agricultural applications? Are these user requirements fulfilled with these results?