

Interactive comment on “Soil Moisture Estimation Based on Probabilistic Inversion over Heterogeneous Vegetated Fields Using Airborne PLMR Brightness Temperature” by Chunfeng Ma et al.

Anonymous Referee #3

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This paper developed and tested the new algorithm of retrieving surface soil moisture from passive microwave observations. Their Bayesian probabilistic inversion can quantify the uncertainties in their retrievals, which is the significant advantage of their proposed method compared with the previous algorithms.

I think this is an interesting paper. This paper is informative, and suitable to HESS. The method proposed in this paper provided the new contribution to the published knowledge.

However, I believe there are things to do described below to reach the full potential of

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this paper. I recommend the editor to accept this paper after major revisions.

Major Points:

L180: Since Ma et al. [2016] has not been published yet, I recommend the authors to describe the short summary and important equations of their method in this paper. Please explicitly describe the cost function equation to be minimized. I guess that the authors used the Malcov Chain Monte Carlo (MCMC)-like sampling. Results of these interferences depend on the hyper-parameters of their probabilistic inversion approach. Please clarify their values and their sensitivities. This point is very important to interpret the author's results and make this paper solid.

L190-194: How did the authors get these values of empirical coefficients in equations (2) and (3)? Are they from Martens et al?

L197: Could the authors provide any references of equation (4)? How was this empirical relationship between LAI and VWC obtained? The authors mentioned that there are no VWC in-situ observations so that it might not be straightforward to obtain this relationship and the authors should explicitly explain how to get it.

L219: I believe that Figure 2, 3, and 4 show the retrieval result at a single grid point. Although these figures demonstrate how the author's algorithm works well, they do not comprehensively and quantitatively evaluate their results. In what conditions do the authors have a large uncertainty in their retrievals? Is estimated soil moisture highly uncertain in the case of high VWC? Please provide site-by-site comparison of the estimated uncertainties. I believe that the potential readers may be interested in this point because the uniqueness of the author's proposed method is the uncertainty quantification.

L219: Please explicitly explain how to calculate uncertainty, skewness, and kurtosis by showing equations. I hope this helps interpret the results.

L225-226: Why can the authors say "SM distribution is well constrained by the PI"? How

can the authors confirm that their retrievals are “well constrained?” Please explain this point more.

L226-227: Up to this point, results of only single grid are analyzed so that it cannot be proved that the MLE represent the SM estimates. As discussed above, please try to include all grid points in the analysis.

L250-255: Although I understand that the authors have no ground observations, I recommend the authors to include the comparison of estimated Hr and VWC between 2P and 3P algorithms. I guess that it helps interpret the difference of soil moisture retrieval performance shown in Figure 5, 6, and 7. In addition, please consider to include the uncertainty range in the estimated SM of Figure 5, 6, and 7. Again, the uniqueness of this paper is the uncertainty quantification so that the authors need to make more efforts on analyzing the estimated uncertainties.

L260: Why can the authors say “the simulated TBs are improved”? When one can say “improved”, one might compared the performance of their model with that of another model. Please consider to modify the expression of this point.

L264: Please explicitly describe the performance scores of Yan et al. [2015].

Minor Points:

L26: The authors have not mentioned that PI is the abbreviation of probabilistic inversion up to this point. Please write “Probabilistic Inversion (PI)”.

L41: easily → easy

L84: needs to the measured → need to measure

L86: I recommend the authors to cite Wang et al. [2015] and Sawada et al. [2016] here. They also proposed the algorithm to objectively estimate the roughness parameters in radiative transfer models.

L121: rang → range

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L227: closed → close

L264 our results are similar “OR” even better than. . .

L280: Although Ma et al. [2016] is the authors’ paper, I believe that here “we” should not be used. Please simply say “Ma et al [2016] discussed the quantification of. . .”.

L296-297: Maybe I missed something but where have you stated it?

L316: we don’t conducted → we did not conduct

L334: The Bayesian PI has been demonstrated → The Bayesian PI has demonstrated

I think that there are many grammatical errors in the present form of the paper. I’m not capable of fixing all of them. I recommend the authors to carefully screen their manuscript to find and fix them.

References

S. Wang, J.-P. Wigneron, L.-M. Jiang, M. Parrens, X.-Y. Yu, A. Al-Yaari, Q.-Y. Ye, R. Fernandez-Moran, W. Ji, and Y. Kerr, “Global-Scale Evaluation of Roughness Effects on C-Band AMSR-E Observations”, *Remote Sens.*, vol. 7, pp. 5734-5757, doi: 10.3390/rs70505734, 2015.

Y. Sawada, H. Tsutsui, T. Koike, M. Rasmy, R. Seto, and H. Fujii, “A field verification of an algorithm for retrieving vegetation water content from passive microwave observations”, *IEEE Trans. Geosci. Remote Sensing*, vol. 54, pp. 2082-2095, doi: 10.1109/TGRS.2015.2495365, 2016.

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