

## ***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 #2**

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The topic and scientific goals of this contribution are certainly interesting for HESS readers. The overall methodology seems to be flawless, but due to the lack of documentation of the implementation and assumptions, questions arise. Without a clear description of the validity of the assumptions, reproducing the presented results is impossible. In addition, several typographical errors are present in this contribution, raising the question if a careful final reading was performed before submitting this report. Due to these typos, the paper does not read fluently enough to be able to focus on the scientific story.

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A detailed description of the Bayesian PI methodology is missing for a paper that uses Soil Moisture Estimation based on Probabilistic Inversion... as a title. Include how the technique works and explain what the differences are with Ma et al. 2016.

With the 2P strategy, it is assumed that the roughness for horizontal and vertical polarizations are the same without any testing. Numerous studies have found that there is a difference between the roughness of both polarisations, so why is it valid to assume they are the same here? This is also dependent on the incidence angles.

The parameters determined by Martens et al. (2015) were calibrated for a specific region, it might be better to perform a calibration of your own. I would suggest to perform a calibration of your own, the VWC can be used directly to calculate the roughness without the necessity to first calculate the LAI based on the VWC if you determine your own regression.

It is stated that in previous work, larger uncertainties were introduced due to the use of a constant roughness (line 330), but there are studies that show that a constant roughness or even a roughness equal to zero can perform very well. For more information, have a look at A. A. Van de Griend, M. Owe, "Microwave vegetation optical depth and inverse modeling of soil emissivity using Nimbus/SMMR satellite observations", Meteorol. Atmos. Phys., vol. 54, pp. 225-239, 1994.

Some general remarks:

When an explicit citation in text is used, following structure should be used: name et al. (year). For example, Ma et al. (2016). Not "as stated by Ma (Ma et al., 2016)" or "as stated by Ma et al. (Ma et al., 2016)".

When multiple references are used, you should choose between ranking them chronologically or alphabetically, not randomly.

For figures, explain the legend also in the caption (what is visualised by the different colours). Also if both the x- and y-axis show the same variable (e.g. SM or TB), the

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distance between the ticks on each axis should be the same. Use square plots in that case.

Be consistent in your reference list. For instance, not every article has a DOI, some DOI numbers have DOI in front of them, others do not.

Sometimes, the paper is written too informal. Extensive use of “we”, “our” should be avoided. Also, previous study, this doing, its, etc. should be avoided.

A complete list of typos and minor comments can be found below. Based on the comments above and the list of minor comments below, I would reject this paper. I strongly advise to perform a screening of the text for additional typos and grammatical errors before resubmitting the revised paper.

Minor comments:

A brief method description is missing from the abstract. Include the model you are using as well as a short explanation of the strategies. At this moment, you introduce 2P and 3P strategies without explaining what it is, leaving the reader puzzled.

L41: complicity should be complexity

L42: ...advanced algorithms were proposed. Some examples are iterative...

L46: Who recognised it? Multiple authors did, so refer

L49: unitized should be utilized

L51: ...represent the physical interactions between the microwave signal and land surface parameters. The optimization...

L54: confidential intervals should be confidence intervals

L72: Also, the PLMR...

L74: PLRM should be PLMR

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L75: ...provided a rich...

L76: ...sensing algorithms...

L81: ...costs time...

L82: modelling

L83: ...as a function...

L84: ...but these need parameterization to the...

L86: It is de Jeu, Richard (2009). Richard is his first name.

L86: ...that Hr can...

L87: However, SM is...

L87: Explicit citation: Martens et al. (2015)

L89: ...(LAI). (Remove last 5 words)

L90: ... to retrieve SM.

L90: The first one is...

L91: The second strategy utilizes the technique proposed by Martens et al. (2015) to estimate Hr and then simultaneously estimate SM...

L93: ... the prior estimated Hr...

L96: ... an estimate...

L98: ... to evaluate the...

L106: include ° sign for the geographical locations

L107: ...the Gobi desert...

L109: ...experiment field, which is located...

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L117: ...PLMR was conducted...

L117: What is v & h? Briefly explain what the difference is between vertical and horizontal polarisation.

L118: Explain HRB

L119: More details of the data can be found in Che et al (2013) and Yan et al. (2015).

L120: ...effect of radio frequency interference, there exist abnormal points...

L121: Also, to process the problem of radio frequency interference, you use a validity range of 180-300K. Are these values chosen arbitrarily? Explain why exactly these values are used.

L121: ...validity range...

L122: ...is converted to a raster format according to its...

L123: The data of July 10, 2012 has the highest quality, but how is the quality checked?

L123: ...because highest data quality is reached here.

L128: ...conducted a ground in situ...

L129: In-situ should be in situ

L130: ...soil were taken...

L131: 21 samples of SM were collected along...

L131: ...(160m row spacing and 80m spacing between each sample),...

L133: ...within a 1.6x1.6 km<sup>2</sup> squared area...

L134-135: Which procedure did you use to determine the VWC of maize? More detail is needed in this section.

L135: ...ranges for the model input.

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L137: ...vegetated fields.

L138: ...in detail by Ma et al (2016), Xu...

L141: ...optimal estimates are represented...

L143: explicit citation

L143: However, this contribution can be distinguished from that of Ma et al. (2016) based on 1) the forward models, 2) data, 3) inversion strategies and 4) comprehensive...

L149: The L-MEB model is briefly described, but it is the main part of this contribution. It has been used a lot, refer to some studies.

L153: A detailed description of L-MEB is given by Wigneron...

L153: What is a tau-w model, if it is mentioned in the text, an explanation is necessary.

L154: ...outputs of the model...

L155: ...soil-, vegetation-, roughness- and sensor...

L158: ...SM, Hr, VWC and effective soil temperature are the most sensitive parameters...

L160: explicit citation

L160: Teff is not as visualised as a symbol

L161: a space after the point

L164: Table 1 contains all the parameters of L-MEB, without an explanation where the used values come from. Are these values from another study or are they calibrated? An answer is given at line 176, but this needs to be explained earlier

L166: Parts 3.2 and 3.3 have respectively 3P and 2P in their title, without an explanation. Briefly introduce these abbreviations before you start to describe the L-MEB

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model.

L169: ...posterior distribution, to quantify uncertainty and to get. . .

L170: SM0 and VWC0 has another font

L172: explicit citation

L178: ...is based on a cost function which minimizes the. . .

L179-180: It is stated that the uncertainty quantification and MLE are very similar to the methods performed by Ma et al. (2016). However, what are the differences? Also, briefly explain how they work.

L180: explicit citation

L180: Ma et al. (2016) provide more details for constructing. . .

L184: ...the approach proposed by Martens et al. (2015) is shown. . .

L189: ...h,v). . .

L192-194: Refer to Martens et al. (2015) when the parameters of equation 2 and 3 are used in equations 2' and 3'.

L195: avoid the use of we

L199: ...utilizing Eq. (2') to calculate Hr is called 2P\_TB strategy and that Eq. (3') is called. . .

L204: ...to get a pixel scale. . .

L221: ...estimates, but. . .

L223: ...and the skewness coefficient indicate that SM. . .

L226-227: It is stated that the SM observation value and MLE are similar, but if Figure 2 is checked, you can see there is a difference. The exact difference cannot be seen

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because not enough xticks are present on the x-axis. However, are these values statistically similar? The range of SM is 0.05-0.5, so a deviation of 0.03 (my estimation of the difference between the SM observation value and MLE) is a difference of almost 10%.

L226: ...the inversion creates uncertainty.

L226: Fig. 2 also shows that. . .

L231: For comparability,. . .

L232: You mention that pixel 5 was used for the 3P strategy; however, this was not mentioned previously.

L232: ...(pixel 5) as performed for strategy 3P.

L233: ...strategies contain larger uncertainties. . .

L236: ...VWC to TB.

L 246: Reached accuracies are better than the target accuracies of SMOS and SMAP of  $0.04 \text{ m}^3/\text{m}^3$ . These are target accuracies for satellite platforms operating at a distance of 700 km, while PLMR operate at 300-750m. Comparing different methods when they are so different has to be performed with caution.

L249: ...a slight underestimation. . .

L257: ...simulated TB

L259: ...(Figs. 8-10). Small. . .

L261: ...those modelled using the. . .

L262: explicit citation

L263: avoid the use of "we"

L263: By comparing,. . .

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L264: ...are similar or even better. . .  
L264: explicit citation.  
L278: The first key issue. . .  
L278: ...Section 3, the Bayesian PI approach presented. . .  
L279: It is stated that the method is different from that of Ma et al. (2016), but the difference is not explained.  
L279: explicit citation  
L280: explicit citation  
L282: ...in the scattering. . .  
L286: inversion, mainly because this inversion. . .  
L286: roughness  
L287: ...parameters as performed by Ma et al. (2016).  
L289: The only references are to previous articles of one of the co-authors, while this is widely known and documented. Include some other references.  
L298: It represents the constraining ability of the algorithm. . .  
L306: explicit citation  
L306: ...feasible for SM. . .  
L306: ...2) reducing the number of. . .  
L307: ...both strategies. . .  
L310: ...multi-frequency, multi-angle. . .  
L315: Not clear.

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L316: ...didn't conduct. . .  
L317: ...that if more observations are used, more accurate results can be obtained.  
L318: Besides, a spectral index derived from optical remote sensing, e.g. NDVI, was used to estimate. . .  
L320: Avoid the use of doing  
L321: ...accurate SM estimate.  
L323: ...using a 6-channel. . .  
L325: Firstly, Li et al (2014) utilized  
L327: Odd point is used to end the sentence  
L328: Don't use previous, refer to the study  
L328: ...data, while Li et al (2014) combined  
L328: Not entirely true. You use PLMR and in situ data of VWC to determine LAI  
L329: Third, TB is used to estimate Hr in the present work, but Li et al. (2014) set. . .  
L330: ...undoubtedly. . .  
L330: In 3P strategy, the variance of. . . .is determined using actual data, but Li et al. (2014). . .  
L334: ...has demonstrated. . .  
L335: ...has shown a. . .  
L340: ...validating using simultaneous. . .  
L341: ...main findings. . .  
L344: ...accuracies (RMSE and ubRMSE) are less. . .

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L348: . . .to the calibration function for model parameter.

L350: . . .result in differences. . .

L350: explicit citation

L400: title has no spaces

L437: it is de Jeu, R.

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