

# ***Interactive comment on “Parameter optimisation for a better representation of drought by LSMs: inverse modelling vs. sequential data assimilation” by H el ene Dewaele et al.***

## **Anonymous Referee #1**

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### Paper summary

This paper describes work done to estimate an uncertain land surface parameter (MaxAWC). This parameter is particularly relevant for land-atmosphere coupling (e.g. transpiration) and for agricultural simulation. Improved knowledge of the parameter is important and will have implications for climate change impact studies as well as shorter term seasonal forecasting.

The authors have used satellite observations of leaf area index (LAI) along with a soil/biosphere/atmosphere model to optimally estimate MaxAWC. The two methods they use are a simple inverse modelling method (essentially choosing the parameter which minimises the RMSE between simulated and observed biomass production),

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and a more sophisticated method which makes use of the data assimilation capability of the model in order to estimate the parameter. The results show that the more sophisticated method gives better estimation of the parameter. Interestingly, they also find that optimal MaxAWC is well correlated with the satellite LAI, suggesting that LAI could be used as a simple method of estimating MaxAWC. However as the authors state, caution should be exercised in extrapolating these results beyond the focus of the study, without further research.

## General comments

The work is technically sound, scientifically interesting and worthy of publication. However I do suggest some revisions to the text for clarity and readability and beyond these specific revisions recommend further proof reading by the authors, a native English speaker and/or the journals editorial team. Particular attention should be paid to clarity in the introduction as improvements here would encourage more readers to engage with the paper.

## Specific comments

P1 L8 “this parameter is usually unavailable” - slightly awkward, perhaps “this parameter is uncertain”

P1 L23 “supervision” - not sure what is meant by this

P1 L29 “This quantity...” - this sentence is confusing and could be improved; please bear in mind any non-expert readers (e.g. “field capacity” is jargon which is fine in the paper in general, however ideally the very first paragraph should give strong accessible motivation for the paper)

P2 L18 “Other studies...” - confusing sentence

P2 L22 Are the units really  $\text{kg m}^{-2}$ ? Total water per volume suggests  $\text{kg m}^{-3}$ . In any case, I am not sure that information on the units is really necessary here.

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P2 L24 “The lack of...” This paragraph should be revised. The first sentence states a problem – though instead of “a significant issue” could you be more explicit? Following this it would help the casual reader to make it clearer that ECVs & data assimilation are potential solutions to this problem

P2 L31 “Besides, data assimilation...”. ‘Besides’ is a strange word to use here.

P2 L22 “In particular, the assimilation of LAI...” This is a key piece of motivating research and it would help to make more of it...e.g “Previous work has studied the impact of assimilation of LAI observations and found that...”.

P3 L1 “The ISBA LSM...” This paragraph describing some results specific to this model in detail is out of place in the introduction – I suggest removing and incorporating the relevant information in section 3.1.

P3 L10 “On the other hand, no more than 27%...presented significant correlations”. Unnecessary elaborate use of language. A clearer way to put it would be: “On the other hand, only 27%...had significant correlations”.

P3 L15 “to retrieve”. Retrieve is used throughout but feels like the wrong word. “Estimate” would be more accurate

P3 L26 “IM and LT. With already a large number of acronyms in the paper, these new acronyms are unnecessary and add to confusion. As a reader I would prefer to continually read “inverse modelling” and “LDAS tuning” method, rather than the acronyms – I found it necessary to remind myself of the meaning of these terms.

P4 L9 “They highlighted that “ “. Why do you quote the author talking about their results here whilst describing results yourself elsewhere? Quotations like this is highly unusual and recommend avoiding.

P4 L11 “They give the following scores...” the R2 values are not really informative, unless you also provide information about the spatial scale, time period (annual, monthly, daily?) that the validation was carried across. But overall I think this entire sentence

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is too much information – I think it is sufficient to say that the product is well evaluated against ground observations and leave it at that. The particularly interested reader can follow the reference.

P6 equation 2. This is two equations, please split.

P6 L18 “The  $t$  superscript stands for time ( $t$ )”. Adding ( $t$ ) is unnecessary.

P6 L19 “The initial time ( $t=0$ ) is denoted by the 0 superscript.” Again, ( $t=0$ ) is unnecessary.

P6 L21 “The  $yt$  term of ...”. The description of these equations is slightly out of order. I would move this  $yt$  up, where you describe all the terms in the  $\Delta x$  equation of (2). After you have described all the terms in this equation, then add the second equation for  $K=...$ , then describe all the terms here.

P6 L22 “i.e. the model predicted value of the observation at the analysis time”. I am not an expert in data assimilation, but this sounds strange. I assume you just mean “the modelled value at the analysis time”. Please reread and ensure that you feel that this whole section is sufficiently precise and clear, particularly for non-experts.

P6 equation 3.  $h$  (lower case) appears to be undefined. Later on in equation 6  $y(x)$  is used. Either a typo or missing description.

P7 L7 “The standard deviation of errors of GEOV1 is assumed to be 20% of GEOV1 LAI”. Why do you make this assumption, do you have any basis? If possible, please explain your reason, or at least help the sceptical reader trust that it is reasonable.

P8 L12-14 It is not quite clear what you did here, by calculating the average  $B$  above a threshold of 90% of its maximum. Why does this limit the impact of model errors? Please explain.

P9 Section 3.5.1. This reads like bullet points, please expand to prose. P9 L7 “by minimising this cost function”. This makes the optimisation sound more complicated

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than it is. Preferably explain as simply as possible i.e., “the MaxAWC used in the simulation with the lowest RMSE was selected as the optimal one.”

Results section generally good, though please re-read for clarity.

Discussion: the structure of the section into five questions is appealing – this approach would be improved if you start each subsection with a clear sentence which answers the question. Currently some sections start with dense recapitulation of the methods, or answers to questions different from those which are posed.

e.g. 5.1 What is the added value of the LDAS? “The LADS approach allows sequential integration of LAI observations into the model”.

Instead: “The LDAS approach leads to more realistic simulations of LAI and Bag. In addition, N does not need to be determined”.

Overall I would recommend editing of this section to make it more streamlined.

Section 5.6 is mislabelled (or section 5.5 is missing). Figures & tables

Suggest moving table 1 / 2 to supplementary material, or making a concise version of table 2 for the main paper and moving the rest to supplementary.

Figure 1: The caption is slightly confusing to read. For one thing, the colour of the symbols is redundant – they are uniquely determined by their shape, therefore you can precisely just use this to refer to them using just the symbol in the caption. Also, “Colour symbols show the departments presenting a significant correlation...” is confusing, when all the symbols are coloured (arguably, black is a colour). Finally, “empty blue circles” is confusing at first, since many of the circles on the plot are filled with another symbol. Suggest instead just “circles”. Overall consider revising and unpacking this caption to make it clearer, and potentially revise the use of colour in the figure. Potentially the figure could be reproduced using just a single colour for all symbols without any loss of precision.

Figure 3: figures too small, would be better if they were placed in a 2x2 panel plot and resized.

Figures 4,5,8,9,10,12 could each be placed on a single row with two figures, rather than a single column. Would help fit nicer on a page. Some could also be combined (e.g. 8 & 9, or 11 & 12).

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