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Hydrology and Earth System Sciences Discussions

Interactive comment on "Uncertainty in the determination of soil hydraulic parameters and its influence on the performance of two hydrological models of different complexity" *by* G. Baroni et al.

Anonymous Referee #2

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General comments

This article investigates the uncertainty of modelling root zone soil moisture dynamics using two models of different complexity, a Richards solver and a model based on a reservoir cascade scheme, in combination with Mualem-van Genuchten parameters derived from three different pedo transfer functions, laboratory and field measurements. The model performance is tested by evaluating evapotranspiration fluxes, average root zone soil moisture content, and fluxes across the bottom of the root zone. The article is well written, the general idea is clearly outlined and the investigation is based on an extensive field data set. The applied parameter estimation techniques

are standard in unsaturated zone hydrology and it is well known that the application of parameters derived from different techniques may lead to differences in model outputs. I see the interesting part of the study in the comparison of the performance of the two different models and the combination of evaluation criteria. I have some comments on the paper and I want to motivate the authors to consider them in a revised version of the manuscript.

Major specific comments

1.) The introduction primarily focuses on the presentation of different parameter estimation techniques and presents a review of their application in various modelling studies. Another important topic of this article is the comparison of the performance of two conceptually different models (SWAP and ALHyMUS) when using different parameter sets. I suggest to add a paragraph to the introduction which explains why it is worth while to compare these two models. This could include a short assessment of the advantages, disadvantages (and probably challenges) when applying both models with respect to the presented field study. This can then be discussed in later sections of the paper.

2.) From the manuscript, for me it is very difficult to imagine how the root zone reservoir in ALHyMUS functions in this modelling exercise. In section 2.3, l. 6–8 it is written that the thickness of the reservoir is variable with the phenology of the crop. As far as I understand, the size of the reservoir grows with increasing rooting depth (finally extending across 4 horizons). On p. 4076, l. 23–28 it is written that the hydraulic parameters of all horizons contributing to the root zone are averaged in order to obtain a parameter set for this reservoir. How is this done technically if more and more horizons contribute to the root zone reservoir?

3.) In order to obtain parameter sets for the ALHyMUS reservoirs the hydraulic parameters of different soil layers are averaged. I see that there is a technical need to

find a parameter set which is representative for the root zone to satisfy the model requirements. However, averaging the hydraulic parameters of various layers may lead to quite a different hydraulic behaviour within the soil profile compared to the layered soil profile as applied in SWAP. This should be pointed out clearly when discussing moisture contents and fluxes and its significance should be discussed critically when assessing the performance of both models.

4.) Concerning the disagreement between measured and simulated evapotranspiration values at the beginning of the simulations I agree with Reviewer 1 that this indeed may result from the initial condition. If additional data are available a warm-up phase could potentially solve this problem. A good example for model warm-up is e.g. given by Jadoon et al. (2008), Water Resour. Res. 44, W09421. Concerning the initial condition applied in the simulations please explain on p. 4076, l. 29 how the measured values were transformed to the model grid/reservoirs (by interpolation?).

5.) From my point of view the performance evaluation for soil water content and bottom flux should be elaborated more clearly:
a) How were the 'measured average soil water content' and 'observed bottom flux' determined exactly? Since this is important for the discussion of model performance please provide the corresponding equations and a comment on the accuracy of both estimations. To be more precise, I suggest to replace 'measured' and 'observed' with a description like 'estimated from measurements'.
b) I suggest to compare the simulated average root zone soil water content and bottom flux exclusively to the 'measured' values, since these primarily are the quantities we are interested in. I do not see much value of equal simulated water contents or fluxes if they do not correspond with the measurements. In this context I recommend to skip Table 6 and 7 and Fig. 6 and to discuss Fig. 5 and Fig. 7 in more detail, e.g., why are the performances of both models that different? Why does one model lead to a reasonable fit when comparing measured and simulated values while the other one is less successful? And finally, what conclusions do we have to draw from these results?

c) For me it is very difficult to extract the information from Figure 7. Probably one could clarify this figure by plotting cumulative bottom flux instead of the daily values. From Fig. 8 I again would be interested in a discussion about why both models perform that differently.

6.) The major part of section 4 is more a summary than a discussion. Probably you could rename section 3 into 'Results and discussion' and use 'Summary and conclusions' for section 4.
Concerning the conclusions I would be interested in a more general assessment of the results, e.g.,
- What is the authors' overall assessment concerning the application of both models in combination with the parameters inferred from the different estimation techniques?
- Which kind of model and which kind of parameterisation should we use in future in order to model root zone water fluxes or are there other approaches which should be explored?
- How can we improve the presented approach in order to reduce the uncertainty in the modelled fluxes and average water contents?

Minor specific comments
1.) The models applied in this study are conceptually very different. Could you – for a better illustration of this difference – provide a figure describing the various soil layers as observed in the soil profile and the transfer of this textural information into SWAP (horizons) and ALHyMUS (reservoirs)? It would also be helpful to indicate minimum and maximum rooting depth in this figure.

2.) p. 4071, l. 5: Here I suggest not to call the CS616 measurement a TDR measurement, even if Campbell Scientific does in the user's manual. Compared to 'real' TDR the CS616 operates at a lower frequency where the dielectric permittivity is not independent of frequency as it is in most TDR measurements. Please also add some information about sensor calibration and temperature correction of the measured val-

ues.

3.) p. 4071, l. 9: Please add information about the meteo sensors used and at which height the measurements were taken since this is important for ET calculations.

4.) p. 4071, l. 9: Please specify/explain PAR sensors.

5.) p. 4071, l. 16: How was the amount of infiltrated water calculated in detail? Please explain.

6.) p. 4076, l. 4–11: I suggest to use $H_{LIM(1...5)}$ instead of H_{LIM}. Please specify parameters a, k and p.

7.) p. 4076, l. 12: Is five horizons for SWAP correct (not four)? If five horizons were used, please specify. What was the vertical profile discretisation used in the SWAP simulations?

8.) p. 4076, l. 14–18: This appears to be the only choice you have with the available data. The soil textures of the upper two horizons given in Tab. 2 are very similar, hence, combining the upper two layers should not have a strong influence on the modelling results compared to the simulations where parameters for all layers are available. In contrast, the textures of horizons 3 and 4 are quite different. Here, one has to consider an influence of the combination of both layers on the modelling results when comparing the outputs to those derived from the 'complete' parameter sets. I suggest to add a comment on this in the paper.

9.) p. 4078, l. 19–23: What was the range (max/min values) in water contents and pressure heads measured at the different depths? Please also indicate this range in Fig. 2.

10.) Figure 3: Please indicate dates were measurements were taken.

11.) Figure captions and legends: I would like to have the figure captions and legends more self explaining. For instance in Figs. 3, 5, 7, 9: Use "measured", laboratory, field,

... in the legends. If you use indices 1), 2) and 3) in the captions, please indicate them in the figures as well.

Technical corrections

p. 4068, l. 10: (Gupta and Larson, 1979; [...], among the others) → (e.g., Gupta and Larson, ...)
p. 4068, l. 13: for instance: → e.g.,
p. 4068, l. 19: see for instance: → see, e.g.,
p. 4069, l. 22: ... be into account ... → be taken into account
p. 4070, l. 1 and other passages: parameters sets → parameter sets
p. 4073, l. 6: There are many occurences throughout the manuscript where sentences are separated by semicolons (here, e.g. place; the). I suggest to use a full stop and start a new sentence (place. The).
p. 4074, l. 4: in laboratory → in the laboratory
p. 4074, l. 6 and other passages: Braekensiek → Brakensiek
p. 4074, l. 15–20 and other passages: Write either van Genuchten or Van Genuchten. I think the usual spelling is lower case.
p. 4075, l. 21: models inputs → model inputs
p. 4075, l. 22: I suggest to delete "and other input data" from this sentence.
p. 4075, l. 24: patterns → values
p. 4076, l. 15: there's no → there is not
p. 4077, l. 18: over estimation [...] under estimation → overestimation [...] understimation
p. 4078, l. 7: depth → depths
p. 4080, l. 12: bad → poor
p. 4081, l. 17–18: please write NRMSE = 0.53...1.23 or NRMSE = 0.53 to 1.23
p. 4082, l. 3: flow → flux
p. 4083, l. 24: please write "close to the potential evapotranspiration"
p. 4083, l. 26: when evaporation → when the evaporation
p. 4084, l. 5: improve → improves

p. 4084, l. 9: an high → a high
p. 4085, l. 5: models performances → model performances
p. 4085, l. 9: badly → poorly
p. 4086–p. 4090: Please use either upper or lower case letters throughout the reference list.
p. 4086, l. 22: please correct: Braden, H.: Ein Energiehaushalts- und Verdunstungsmodell für Wasser- und Stoffhaushaltsuntersuchungen landwirtschaftlich genutzer Einzugsgebiete, Mitteilungen der Deutschen Bodenkundlichen Gesellschaft, 42, 294–299, 1985.
p. 4088, l. 19: Please remove reference Maraux et al. (1998). I could not find it in the text.
Table 2: Silty → Silt
Table 5: I think CV should be given as a dimensionless number (CV=stdev/mean).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 4065, 2009.