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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Feasibility analysis of using inverse modeling for estimating field-scale evapotranspiration in maize and soybean fields from soil water content monitoring networks" *by* Foad Foolad et al.

Anonymous Referee #1

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The study addresses an important issue of enlarging the data sets available for LSM validation by estimating AET from SWC measurements. Also the underlying idea that recharge and AET data are generally more valuable to society than SWC alone justifies this field of research. The manuscript is very well written.

However the inverse methodology description is very weak. There is no description of which search method is used! What is the combined objective function? A detailed sensitivity analysis has to be given, especially in light of the mentioned problems

of equifinality. It is extremely unlikely that all 24 parameters are sensitive and justify optimization. Also inverse modelling offers the opportunity to provide the reader with an estimate of the confidence intervals for each estimated parameter, which will also reveal the sensitivity and associated uncertainty.

The results on simulated SWC seems to be reasonable from a SWC perspective, but its important to also address the certainty/robustness and likelihood of the estimated soil parameters. Are they random parameter picks from an equifinal problem or are they physically reasonable and do their mutual differences fit into field/lab measurements (I assume soil samples exists from the sites) ? The author have attempted to validate the spatial distribution of the estimated soil parameters based on a soil map, which is highly appreciated. However it would have been interesting to utilize this information for regionalizing the soil parameters and thereby limiting the number of free parameters in the calibration. Likewise the soilmap could have been used to upscale the AET simulations to the field scale by including the soilmap instead of a simple average of the four points.

The results of the AET simulations seem to be very poor. I miss a critical view on the results regarding lacking ability to simulate even interannual variability (fig 11) and perhaps more importantly the apparently complete lack of predictive capability on the daily scale. The performance metrics in Table 6 indicate good R2 and NSE, but that correlation is intrinsically given by the seasonality of the climate. The real test is if the model has any predictive power on estimating the evaporative fraction AET/PET. If you normalize the AET on a daily timescale by the daily PET and then calculate the R2 and NSE, you probably get no explanation of variance. This can also be somewhat illustrated in table 6, if you add a column of RMSE in % of average daily AET, then you see that the RMSE is in the order of 50-80% of the daily AET (see attached table). In comparison most Remote sensing AET methods can, with calibration, achieve results in the order of RMSE of 25-30% of the daily mean AET.

Given the very little detail available on the AET model used (Feddes 1978) I can only speculate, but perhaps the simulated SWC is not accurate enough at the critical moments when AET is limited by water availability, or the AET model is not appropriate or the climate data are poor. But overall I do not find the results on simulated daily AET encouraging. AN uncertainty analysis of teh different model components would be appropriate (see comment below)

Q: footprint analysis? EC footprint of 250 m radius is very large, what is the height of the EC mast?

Please explain the reasoning behind eq. 2 and 3?

L168: The Actual Transpiration is calculated using Feddes 1978 based on Tp and root density distribution. That must be a key component of this approach, please give more details on the application of the Feddes model.

L198-204: Optimized against which objective function? What was the calibration target? Which optimization algorithm (gradient based/global etc.) is used? That has to be clear up front? Also what was the result of the sensitivity analysis? Which type of sensitivity analysis, was it necessary to optimize all parameters? And why not calibrate all four layers simultaneous?

L220-224: It might be obvious, but please state clearly, which observation data the performance metrics are based on.

L230: How are the best defined, what are the weights and how was your combined objective function defined?

L265-266: Ofcause the upper layers are better, you calibrated them first and then kept them fixed while calibrating the lower layers, so they have had significantly more freedom in the optimization. Try to calibrate the lower first and then fix them and calibrate the upper, then you might get a different results.

L336: “the various ETa estimation techniques performed well.” I disagree.

L337: “In fact, it is difficult to identify which is the clear solution if any.” Please rephrase

Fig 9: How come the simulated values cannot go down to 0.20-0.25 for the Cosmic ray calibration, when that is possible for the TP calibrations?

Fig 11: The proposed method seems to not capture the interannual variability, try to plot the annual values of EC against simulated annual values in a scatterplot to see if there is any correlation on an annual basis?

Fig 13: You need to plot the daily obs vs. simulated AET in a scatterplot, the accumulated curves gives no indication of the performance of the daily model simulations! The bias of the Scatter plot will however give you the same information as the offset in accumulated values.

Table 6: Needs units.

I suggest resubmission of a new manuscript after major development of the inverse modelling and careful rethinking about the quality of the daily AET simulation results and reasons for the insufficient performance (AET model concept, upscaling, SWC simulations at critical stages, uncertainty in soil parameters, climate data etc.) . Here I would suggest some uncertainty analysis of the relative importance of these factors for the final AET results. E.g. how important are changes in soil parameters to the final result? And how important are the assumptions in the model (e.g. root depth, soil profile depths etc.)

Good luck

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Table 6: Assuming average daily obs. AET of 612/365 mm/day (from table 7)

Location	R2	MAE	RMSE	RMSE % of daily mean AET	NSE
TP1	0.652	0.696	1.062	63.3%	0.618
TP2	0.754	0.61	0.907	54.1%	0.746
TP3	0.751	0.601	0.904	53.9%	0.728
TP4	0.413	0.878	1.387	82.7%	0.168
CRNP	0.499	0.787	1.259	75.1%	0.349

Fig. 1.