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Hydrology and Earth System Sciences Discussions

Interactive comment on "

Towards a more representative parametrisation of hydrological models via synthesizing the strengths of particle swarm optimisation and robust parameter estimation" *by* T. Krauße and J. Cullmann

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Dear reviewer,

we greatly appreciate your thoughtful comments that helped improve the manuscript.

We trust that all of your comments have been addressed accordingly in a revised manuscript. Thank you very much for your effort.

>General comments >This paper presents a new calibration method for hydrological models based on Particle Swarm Optimization and >robust parameter estimation. The paper is well structured, quite interesting and fits in the scope of HESS. However, >there are still some major adjustments that have to be made before the article can be published. First of all, the >authors often refer to another paper that is also submitted to HESS. Without this paper some aspects cannot be >understand. When I read the other paper, I noticed a strong overlap between the two papers. Therefore, I strongly >recommend to merge the two papers into a single paper. As the abstract, the introduction, the benchmark >functions, the hydrological model and a part of the used algorithms are more or less the same there is âĂŤin my >opinionâĂŤ not enough new information to justify two separate papers.

We merged the manuscripts of both papers and struggled to present an attractive paper. In the following, we give a point-by-point reply to your comments:

>Specific comments >1) The used calibration methods should be discussed in more detail. For example, in the description of PSO, the >parameters of PSO are not discussed. What do they mean? What values were used for these parameters? How were >these values determined? The PSO algorithm is combined with a VPAC crossover operator, what is the added value >of this operator? What is the chosen neighbourhood for the particles? What was the stopping criterion? How can the >particles converge when a portion of the population is always pushed away from the group? Are the results of the >PSO_GA algorithm compared with results of the standard PSO algorithm? What was the difference?

We completely reedited this section and introduced a brief discussion on this issue and introduced an overview of the used algorithm parameters. Additionally we briefly explained their functionality and provide literature references how to set them and what

to be considered. In our opinion the setting of the PSO parameters is a classical issue of PSO research and should not be explained in to much detail. The breeding ratio that determines the rate of the population that is not moved according to PSO but GA. This parameter is highly dependent on the considered problem. For further details refer to Settles2005 and referred literature.

>2) Page 2384 line 28: what is the difference between personal best position and personal global best position?

We inserted a discussion on this issue (see page 8/9). "An important difference between a normal PSO algorithm considers the movement at the end of each iteration. I nstead of moving the whole swarm towards the so far found global best position, the algorithm assigns to each particle one random member of the archive $\vec{\hat{g}}_i \in \vec{X}^\ast$. We call this member \enquote{personal} global best (see Algorithm \ref{alg:PSOGAU}, line 14)"

>3) Page 2386 line 1: the original personal best position is replaced by a parameter vector stored in the archive X*. >This to ensure that the algorithm not just searches into the direction of the so far found global optimum but >searches the whole region within the given tolerance (line 1-3). However, by removing the original personal best >position there will be less exploration? How is the best position found so far by each particle taken into account? >Why is this replaced by a parameter vector stored in the archive X*, what is the added value of this decision? There >needs to be more discussion about this subject.

We edited this section. "Another issue affects the update of the local best position $\vec{\hat{x}}_i$. Unlike in a normal PSO, it will only be changed in case that the old local optimum corresponds to a model performance worse than the global optimum plus the uncertainty bound. That measures prevent a to small shrinking of the swarm and ensure that the algorithm not just searches into the direction of the so far found global optimum but samples from the whole region within the given tolerance." You

might also refer to the answer of question 2.

>4) Algorithm 2.4: the authors refer to the GenDeep algorithm. It is necessary to include this algorithm in the paper. >This is another confirmation that it would be better to combine this article with the other article the authors >submitted to this journal.

We merged both papers. The GenDeep algorithm is now listed and introduced within the new manuscript.

>5) In several cases, the authors write that the results are significantly different (page 2387 line 16, page 2390 line >4, page 2390 line 21,...). Which statistical test is used to compare the results? The used statistical test should be >mentioned and justified.

Of course the term significantly is not used as a statistical term but rather as a synonym for the term 'clearly'. To avoid any ambiguities we changed this issue in the new manuscript.

>6) Page 2391 line 24-26: The authors refer to the approach of Grundmann to explain the mapping of the >computed set of parameter vectors to two scaling parameters. However, this is a reference to the dissertation of >Grundmann, which is written in German. Therefore, it is not possible to understand this method. It is necessary to >give some explanation about this approach.

We edited this section and briefly introduce the main idea of this approach. In our opinion the new section provides sufficient information about this approach. Thus, we do not want extend that too much, because a total understanding of Grundmann's approach is neither the focus nor completely essential for the understanding of this paper.

>7) Page 2392 line 1-4: Different distributions are given in Fig. 7 for the soil hydraulic parameters. The distributions >of the corresponding scaling parameters are given in Fig. 8. How are the distributions of the corresponding scaling >parameters created? For which reason are these distributions created? Which of the four (Gaussian, loga-

rithmic >Gaussian, Gamma and bimodal Gaussian) distributions is used? This part of the paper is very unclear to me.

We edited this part of the paper and explained the fitted distributions. ("The fitted distributions are just an additional information in order to show that the estimated prior distributions could also be described by commonly used distribution functions."). The scaling is done according to Warrick 1977. This is explained in Section 4. We inserted a reference while reediting this part of the paper.

>8) Page 2392 line 12: what is the range for the parameters krec, βSL and βSiL?

krec is no soil hydraulic parameter but an additional conceptual model parameter of the soil module. We inserted a short description into the manuscript: "krec defines the gradient of the saturated conductivity ks with increasing soil depth and has a valid range between 0.01 and 1. Its default value estimated by water balance calibration runs was set to 0.1. Hence we con- sidered both krec and the introduced soil hydraulic parameters together with the conceptual model parameters for model calibration."

βSL and βSiL are scaling parameters that are generated by a scaling of the soil hydraulic parameters of the soils SL and SiL according to Warrick 1977 as proposed in Grundmann 2010. Therefore these parameters do not have a fixed range. This issue is also briefly explained in section 4.

>9) Page 2392 line 18-19: Why is it evident that the particle swarm based parameter estimates are distributed over a much smaller region than those estimated by AROPEMC ? This should be included in the text. >10) Page 2392 line 28-29: Why is it obvious that the spread of the distribution of the soil hydraulic parameters compared to their prior uncertainty gets smaller? How are the distributions of the soil hydraulic parameters (in Fig. 11 and 12) created? These aspects should be explained in the text.

This section was really to vague . Therefore we edited this part of the paper and

inserted discussions about the mentioned aspects.

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>Technical corrections >1) Both British and American English are used. The authors should be consistent and follow the author guidelines for this matter.

We checked the paper once again. There are some spelling variations that can be used both in AE and BE. In case that there are any further mistakes further reports are welcomed.

>2) Figures and tables are not presented in the right order. Figure 1 should be the first figure to discuss, etc.

The order of the Figures and tables was corrected and checked for the new manuscript.

>3) Page 2378 line 11-12: ROPEPSO evolves previous robust parameter estimation algorithms by means of >performance and efficiency. “Evolve” seems not to be the correct verb in this sentence.

That section was edited in the new manuscript.

>4) Page 2384 line 8-10: Hence the proposed method suffers from the shortcomings of the Monte Carlo method a >slow convergence ... This sentence is not grammatically correct. >5) Page 2390 line 23: kd and dr is approximately... instead of kd and dr is the approximately

Thank you for these hints. We corrected them.

>6) Page 2391 line 3-10: In which table are these results presented?

We inserted a reference to Table 7.

>7) Page 2391 line 20: Table 4 is not the correct

We corrected the reference to Table 8.

>8) Page 2392: what is the meaning of MVG?

That means "Mualem - Van Genuchten model". We inserted the complete term in the new manuscript.

>9) Page 2393 line 7: can be much better identified instead of can by much better identified

Thank you for that hint.

>10) Page 2407 table 7: where can we find the parameter krec?

krec is no soil hydraulic parameter but an additional conceptual model parameter of the soil module. That is why it is not listed in table 7. However, we inserted a short description into the manuscript: "krec defines the gradient of the saturated conductivity ks with increasing soil depth and has a valid range between 0.01 and 1. Its default value estimated by water balance calibration runs was set to 0.1. Hence we con- sidered both krec and the introduced soil hydraulic parame- ters together with the conceptual model parameters for model calibration."

>11) Page 2415 fig 8: what is βLu?

This figure has an error. We corrected it. βLs = βSL, βLu == βSiL

Thank you very much for your effort!

Kind regards Johannes Cullmann and Thomas Kraußе

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 2373, 2011.