Dear editor,

Please find hereby my review report of the manuscript “Towards a more representative parametrisation of hydrological models via synthesizing the strengths of particle swarm optimization and robust parameter estimation”.

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 —in my opinion— not enough new information to justify two separate papers.

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

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.
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.
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, logarithmic Gaussian, Gamma and bimodal Gaussian) distributions is used? This part of the paper is very unclear to me.
8) Page 2392 line 12: what is the range for the parameters k_{rec}, β_{SL} and β_{SiL}?
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 $AROPE_{MC}$? 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.

Technical corrections

1) Both British and American English are used. The authors should be consistent and follow the author guidelines for this matter.
2) Figures and tables are not presented in the right order. Figure 1 should be the first figure to discuss, etc.
3) Page 2378 line 11-12: $ROPE_{PSO}$ evolves previous robust parameter estimation algorithms by means of performance and efficiency. “Evolve” seems not to be the correct verb in this sentence.
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: k_d and dr is approximately… instead of k_d and dr is the approximately
6) Page 2391 line 3-10: In which table are these results presented?
7) Page 2391 line 20: Table 4 is not the correct table.
8) Page 2392: what is the meaning of MVG?

9) Page 2393 line 7: can be much better identified instead of can by much better identified
10) Page 2407 table 7: where can we find the parameter k_{rec}?
11) Page 2415 fig 8: what is β_{Lu}?