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Hydrology and Earth System Sciences Discussions

Interactive comment on "Multi-objective calibration of a distributed hydrological model (WetSpa) using a genetic algorithm" *by* M. Shafii and F. De Smedt

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Responses to comments of the Anonymous Referee 2

We would like to thank this reviewer for the provided comments. To frame the response, the Authors, within this text, provide the comments in their original format, followed by corresponding responses. Furthermore, as there was a need to re-organize and rectify the paper, a revised version of the paper will be uploaded for consideration of the reviewer. In order to better trace the corrections, the edited/added parts will appear in red in the revised paper.

1. "The paper discusses the problem as being a Pareto problem, however, I do not see CR1, CR2, CR3 as a set of mutually contradicting objectives. I.e., I doubt that minimizing CR1 will result in increasing CR2 or CR3 and vice versa! Therefore I doubt that the term Pareto front and Pareto optimal are correctly used! I believe the whole problem should better be described in the framework of equifinality! (also the left panels in figure 3 are not really convincing me of being a Pareto front!)."

Response: We agree that usually for a multi-objective optimization formulation, objective functions should be conflicting. To our experience, there is a certain level of contrast between the applied objective functions in this study, especially CR2 (i.e. Nash-Sutcliffe value with more emphasis on high flows) and CR3 (i.e. more emphasis on low flows). CR1 stands for error in mass balance and also interesting to be considered. In fact, the results show that those parameter sets which result in good CR2 values deteriorate CR3, and vice versa. Hence, a certain level of contrast between these objective functions exists providing a proper framework to apply the Pareto-based NSGA-II algorithm. The referee has correctly pointed out that the concept of equifinality can also be used in this respect. This has been also dealt with in Section 3.2, paragraph 4 in the revised paper.

Concerning the left panel of Figure 3, we can say that (i) plotting a 3D Pareto front within 2D graphs is not that comprehensive, and (ii) as one of the axes (CR1) is a minimization objective function and the other one (CR2 in upper and CR3 in lower graphs) are maximization ones, the spread of points is not that straight-forward to show a Pareto front. This is not the case for the right panel, as both objective functions follow a same direction (i.e. maximization). Nevertheless, there is no doubt that these points are all Pareto front solutions as none of them is superior to the others along all objective functions, while we also show in the revised paper that the search algorithm has converged.

2. "I believe that paper would merit from better describing the different techniques used

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(i.e. NSGA-II and PEST), mainly focusing on their differences: a non-linear and global search algorithm versus a linear local search technique is quite different. Furthermore, the comparative study that has been conducted is not really fair as NSGA-II is able to use multiple criteria, whereas PEST only uses one. Therefore, it would be best to compare both techniques in an exercise where only CR2 is minimized. Furthermore, the results obtained should be better compared to other comparative studies that have been published (e.g. Tang et al., HESS, 10, 289-307,2006; Wöhling et al., Soil Sci. Soc. Am. J., 72, 305-319, 2008)."

Response: The authors agree with this comment that they have not been able to properly express their goals using NSGA-II and PEST. Therefore, more information about PEST, NSGA-II, and their differences, along with a re-interpretation of the results has been provided in the revised paper (i.e. Introduction, paragraph 4, lines 4 to 6; Section 2.4; and Section 3.1, paragraphs 4 to 6), according to suggestion of the reviewer. We also added suggested references to the paper.

3. "The paper also concludes that NSGA-II better performs than PEST, however from the text, this conclusion is not really convincing. This should be demonstrated in better detail. The discussion that tries to demonstrate this is rather weak, and some strange statements are made: e.g."the solution with PEST is not Pareto optimal", it cannot be Pareto optimal since it only uses one criterion in for calibration."

Response: As previously mentioned, the authors have put more efforts in the revised paper to express their objectives for applying NSGA-II together with PEST. Hopefully, the new paper will be able to clarify any misgiving. Further, the phrase "the output solution of PEST is not Pareto optimal" has been deleted from the paper.

4. "I believe the paper could be much improved by discussing more in depth the techniques used and by mentioning what type of minimization technique (global vs. local) they are and what effect this will have on the calibration exercise! (e.g. since PEST

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is a local search algorithm, it should be repeated several times with different initial parameter sets). Furthermore, an in-depth discussion with respect to other papers that compare similar calibration procedures would definitely be beneficial to the paper. I believe, the current length of the paper definitely allows to elaborate more on these issues."

Response: As already pointed out, this is better explained in the revised paper, i.e. goals of study, and re-interpretation of the results, see (i) Section 2.4 which includes a brief explanation of PEST, along with how these two models are applied, and (ii) Section 3.1, paragraphs 4 to 6 which show the obtained results and their corresponding re-interpretations.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 243, 2009.