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Hydrology and Earth System Sciences Discussions

Interactive comment on "Comparison of different multi-objective calibration criteria of a conceptual rainfall-runoff model of flood events" *by* N. Chahinian and R. Moussa

Anonymous Referee #1

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General comments:

The paper addresses the problem of calibration of an event-based rainfall-runoff model. The problem is investigated within a multi-objective context considering different objective functions, and analyzing calibration results based on single objectives and different combinations of two and three objectives.

The overall quality of the paper is good. It is, in general, well written and technically sound. It provides an interesting and comprehensive analysis of model calibration using six different objective functions. The use of multiple objectives in model calibration has been advocated and demonstrated in several publications in hydrological modelling

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in the last 10 years, and hence the idea presented in the paper is not new. However, the paper provides a very comprehensive analysis on the subject, providing valuable insight into the calibration problem. Especially, the use of both absolute and relative event-based average measures and their combination is interesting.

Specific comments:

1. The applied calibration procedure is not clear (mentioned on page 1041, l. 11-13). It is stated that no optimisation as such is applied, but the calibration is based on 50,000 model simulations using a progressively finer grid (in parameter space). How is this progressively finer grid adaptation being done? I expect some kind of optimisation rules are applied to guide the grid adaptation to focus on more promising regions in parameter space? Is the procedure similar to adaptive cluster based methods? The applied algorithm should be described in more detail in order to evaluate its effectiveness in single-objective and multi-objective Pareto optimisation. Especially, for the Pareto optimisation it is not clear if this is done in one calibration run using a Pareto criterion or as several single-objective calibration runs with different weight combinations of the objective functions.

2. A balanced aggregate optimum is defined, referring to the work by Madsen (2000). However, it is not clear how the transformation constants are calculated for defining this balanced optimum, cf. Eq. (18). In Madsen (2000) the transformation constants were calculated automatically as part of the optimisation using simulation results from the initial population for the shuffled complex evolution search. But here it seems that the balanced optimum is calculated based on all simulation results (page 1046, l. 15-16)? This issue is important in relation to how the optimisation is actually being done as noted above. If the applied procedure is Pareto-based, then there is no need to introduce a transformation as part of the optimisation. However, if a weighted single objective optimisation is done, then it makes sense to introduce a transformation to compensate for different scales and units in the objective functions.

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3. The problem of equifinality is discussed in the paper (page 1046, l. 3-5 + p. 1051, l. 22-25), referring to Beven and Binley (1992). However, it is important to distinguish equifinality as defined by Beven and Binley (1992), and which forms the basis for the generalised likelihood uncertainty estimation (GLUE) procedure, and trade-offs between different objectives in a multi-objective optimisation framework. The former is related to the fact that different parameter sets may give very similar model performance measured with respect to some likelihood measure (or single objective function), whereas the latter is referred to as multi-objective equivalence of parameter sets and defined in terms of the Pareto criterion (see e.g. Madsen (2000) for a discussion of this).

4. In the optimisation the shape parameter z of the unit hydrograph model has a feasible range that covers several decades (0.01-100). Was the native real value or a logarithmic transformed value used in the optimisation? A log-transformation would allow to better distinguish between very small and very large values.

5. On page 1040, l 7-8 it is stated that RMSE to a certain extent is comparable to the Nash-Sutcliffe (NS) efficiency measure. In fact, NS is a standardized RMSE measure, and hence there is a one-to-one relationship.

6. On page 1034, l. 5-6 it is stated that this study extends the use of the balanced objective function in Madsen (2000) to more than two objective functions. In fact, Madsen (2000) introduced four objective functions, and all four were actually applied in the balanced measure used in the optimisation in Madsen et al. (2002).

7. In the application example catchment rainfall is calculated as the arithmetic mean of the seven rain gauges. However, I would expect rainfall in the area to be highly variable and influenced by topography, and hence a simple average of the rain gauges to be possibly biased (depending on the location of the gauges).

8. On page 1050, l. 1-4 it is noted that the maximum values of the objective functions when using multiple objective calibration are always lower than those obtained when

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using single objectives. But isn't this just a consequence of the trade-offs?

9. The volume-based objective functions seem very small, less than 0.0001 m3 cf. Fig. 4, as compared to the relative volume errors, which are in the order of 5-25 % cf. Fig. 5.

10. What does the curves (bold and dotted) show in Fig. 8? Compared to observations?

11. On page 1040, the objective functions are defined in the text in the order: volume error, peak flow error and RMSE, but are defined in a different order in the equations below.

Technical corrections:

1. I would prefer to use "single-objective" rather than "mono-objective"

2. Page 1032, l. 11: "parameter" -> "parameters"

3. Page 1032, l. 23: "chose" -> "choose"

4. Page 1034, l. 19 (and other locations): "strong events" -> "larger events"

5. Page 1035, l. 15+17: "noted" -> "denoted"

6. Page 1036, l. 11+19: "calculated function of" -> "calculated as function of"

7. Page 1037, l. 6+18+19: "resolution of the diffusive (kinematic) wave equation". Wouldn't "approximation" be a better word than "resolution".

8. Page 1037, Eq. (7)+(8)+(9). Remove dots used as multiplication.

9. Page 1039, l. 5: "such as maximum value of the infiltration capacity" -> "that relates the minimum and maximum infiltration capacities, i.e."

10. Page 1039, l. 9: "calculated function of" -> "calculated as function of"

11. Page 1040, Eq. (15): There is a missing 1/Qoij in the relative RMSE expression.

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12. Page 1042, l.25: “carried out function of the triples” -> “carried out using all functions of the same type”

13. Page 1047, l. 11: “range within” -> “is within”

14. Page 1048, l. 3: “septuplet” -> “parameter”

15. Page 1048, l.15: “SAM” -> “SMA” (soil moisture accounting)

16. Page 1049, l. 19 (and other locations): “maximal” -> “maximum”

17. Fig. 2 caption: add peak flow and initial storage.

18. Fig. 8 caption: “high(low) event” -> “high(low) intensity event”

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 1031, 2007.