

Interactive comment on “Technical note: the caRamel R package for Automatic Calibration by Evolutionary Multi Objective Algorithm” by Céline Monteil et al.

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We would like to thank Guillaume Thirel for constructive comments on our manuscript and the script suggestion. The comments are helpful and will certainly improve the quality of our manuscript. Below we provide the Reviewer's comments verbatim in black italic text, and our responses are immediately below each comment in blue text.

The topic of R packages that are dedicated to hydrology is relevant to HESS, as demonstrated the very recent review paper by Slater et al. (2019) in which I participated. I think that this paper should be mentioned in the manuscript, not because I

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co-authored it, but because it justifies the interest of such packages to the hydrological community. Indeed, a basic search for the word "package" in the titles or abstracts of HESS papers does not provide so many results.

Thank you for this very interesting paper, we will add the reference.

I understand from discussions between the editor and the authors (not available online) that a first version was submitted to another journal and it was suggested to focus more on the package than on actual comparison of algorithms impacts. That can be true for model-oriented journals, such as EM&S and GMD (see for instance our airGR paper in EMS, Coron et al., 2017, which was a Short Communication). However in my opinion HESS is different: describing software and providing pieces of codes is very much appreciate (for the sake of reproducibility), but we also need science. Simply describing packages or tools is not the main aim of HESS. Here the science is a new calibration algorithm and its impact. As a consequence, more emphasis should be put on that two points, but the Editor Elena Toth already commented on that and I agree with her. In the end, I'm wondering if this paper will remain a Technical note or become a full research article.

We will add a new example of hydrological calibration with GR4J in order to have more results to discuss. We also intend to change the paper title to focus more on the algorithm and less on the R package: "Multiobjective calibration by combination of stochastic and gradient-like parameter generation rules: the caRamel algorithm".

Overall, the paper is good, it is of interest for the HESS readers in my opinion, and provided that the objectives of the paper are modified as mentioned below and above, I am confident that it will be published later on.

Thank you.

Main criticism: My main criticism regards the fact that the authors submitted a

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manuscript into an open journal, for presenting an open source software, but they illustrate it with an hydrological model that is not open! While I know that MORDOR is the historical EDF hydrological model and using the MORDOR model with caRamel makes sense for the authors, this in my opinion is much less obvious for the readers. I guess that the aim of the authors is to make readers understand that caramel is a valuable tool for calibrating hydrological models available in R. However, no mention is ever made of the fact that there are hydrological models available in the R environment, justifying the interest of this new package. Indeed, readers cannot manipulate the MORDOR model, they only have brief knowledge of the parameters meaning from this paper and they cannot run the lines of codes provided by the authors to handle the package. I think that this is a pity, as the authors made a laudable effort to provide an open source software, some vignettes and also some lines of codes. In addition to the fact that the model is not available, no example data are provided. All of this does not prevent from using the package, but I find it damageable to stop so close to total openness. As one of the developers of the airGR R package, as you know, I tested the caRamel algorithm with a simple GR4J model and an example dataset included in the airGR package. It is not difficult to make it work, but from what was provided it is not straightforward (I guess that the fact that I know well my package helped, but for people using caRamel with a package they did not develop it could be more difficult). I provide the lines of codes I wrote at the end of this review. I would therefore suggest to the authors to include a full example, i.e. one that could be reproduced by the readers, with one open (and well-known if possible!) hydrological model and one open dataset. I don't think this is much work and I don't think that would deeply impact the paper, but I feel that would be useful. Of course, as I provide some lines of codes in this review (see the figures 1, 2, 3, as well as the supplement for the R file) and as some authors know well the GR models, airGR would be a straightforward solution, but as highlighted in Slater et al. (2019) (see section 3.5), other well-known hydrological models are openly available in other R packages.

Thank you very much for these lines of code. We will add an example of multiobjective

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calibration of GR4J, with the data from the R package airGR (Coron et al., 2017; Coron et al., 2019)

Major remarks:

Introduction: nothing is said about composite criteria (e.g. an average of KGEs). I think it should be mentioned and discussed on the base of a couple of references. That's what I tested in the code I provided and the results in terms of performance are quite similar to the multi-objective calibration with the same objectives. This is also much faster, but I guess that the choice of the convergence threshold of caRamel is important in this example.

The idea of multiobjective calibration is to provide a family of parameter sets and not only one set. We will discuss it with the additional example.

Heterogeneous spelling in the text: see for instance "Multi Objective" in the title, "multiobjective" and "multiobjective" in the abstract. Or "modelling is the abstract but "modelling" in L. 2, P. 2. "R package" in the title and "R-package" in L. 8, P. 2. "Pareto-front" in P. 5, L. 14 and "Pareto front" in P. 5, L. 28, "Pareto Front" in P. 9, L. 12. Please try to be consistent all over the manuscript! I did not spot all of them here.

Thank you, we will correct it.

About section 2.1.1, which describes the generation of parameters. I had difficulties to understand the complete functioning of the 5 rules. First, are these 5 rules or in fact 5 steps that are undertaken successively? In addition, a figure is presented for the first two steps, but it is not used efficiently to make things clear for the readers. I have the feeling that this could be improved easily. For example, why not using only 2 parameters instead of 3, as 3D plots are not possible here? That would simplify things. There are also terms in the legend that are not explained, such as "Example" or "Simplexes". Since the figure is quite complex, with many points, triangles, arrow,

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it is necessary to help us to read it. I would also maybe suggest a concrete example somehow, especially about the evolution of the parameters sets number, as it is stated at L. 20 that it is necessary to reduce the number of sets. Maybe specify that no parameter set is discarded during the 5 rules stuff?

Thank you for your suggestion, we will try to clarify this section.

Section 2.1.2: quite similarly to the previous section, I find that Fig. 2 is underexploited / underexplained. Levels 2 and 3 are never referred to either in the text or in the caption.

We will add some more explanations.

Section 4.1: Results are presented for the Kursawe function in Fig. 3. Here again some improvement is possible that would help our reading. What is the optimum for the two objectives? Caption: MCO is not mentioned regarding the number of evaluations; is it 1000? Or does that mean that Fig. 3a only concerns caRamel? If so, why? (I guess this is the case from the reading of the text, but then the caption could be improved). We could have a similar graph for mco.

Ok, we will correct it.

Section 4.2.4: Figure 5 is quite difficult to read, in the sense that there are too many points and the superposition of the two algorithms results does not permit to see the differences. Maybe you should separate the two algorithms in two different graphs for each panel? In addition, we don't know from which algorithm are chosen the red points, if I'm not wrong. Red points are chosen from the caRamel optimization, we will mention it in the text. Regarding the name of the package, I recommend, if you use LaTeX, to use the texttt font. This is what we did in Slater et al. (2019) and I think it helps the reading a lot. In addition, it helps making the distinction between the package and the main function, which have the exact same name. We also adopted

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the spelling "R package" instead of "R-package".

Thank you for this suggestion but we are not using LaTeX. We will use the spelling "R package".

Section 3: I would like to have access to the equations of the metrics, as these are not common metrics used by hydrologists.

We will add the equations.

References:

- Efstratiadis and Koutsoyiannis: this is a conference abstract. What do you think about citing their HSJ paper entitled "One decade of multi-objective calibration approaches in hydrological modelling: A review ?

We will mention this paper in the introduction and we will add another reference to a book chapter for MEAS.

- Garavaglia et al. : this paper has been published in 2017, please update.

We will update it.

- Le Moine 2009: I think we need a link towards the pdf of this report.

We will add the link: <https://www.metis.upmc.fr/lemoine/docs/CaRaMEL.pdf>.

- Monteil et al.: any paper or accessible report or presentation instead of this EGU abstract?

We will add a link toward the presentation.

- Riquelme et al.: Conférence is written in French Ok, we will correct it.

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Minor typos and miscellaneous minor stuff:

I found a bunch of very minor typos that could easily be dealt with by the authors. As a non-native speaker myself, I hope I'm correct when suggesting these modifications and also that I'm not too picky... I also do not guarantee that I spotted all of them!

Page 1:

L. 12: remove "algorithm" after NSGA-II as the A of NSGA stands for "algorithm" ok

L. 20: The first sentence of the introduction is the same as the first one of the abstract, except for the word "calibration" that is replaced with "prescription". I personally prefer "calibration". ok

L. 22: I would add a comma after "precisely" ok

L. 23: not 100% sure, but I think that here "statistic" should be spelt "statistics" ok

L. 24: "well-knowN" ok

Page 2:

L. 7-8: please revise the format of citations (i.e. add commas around the years). In addition, I think that the citations should be ordered either by alphabetical or by chronological order. ok

L. 8: as I guess this is the case for all citations, I would rephrase the parenthesis as follows: "all previously to the release of the R package" ok

L. 9: "of THE caramel algorithm" ok

L. 11: I would say "simply has" instead of "has simply" ok

L. 17: as it is an adjective to the word "objective", I think that "low-flow" is more correct. At this line and all other occurrences, I would remove the capital letter to "hydrology". ok

L. 22: either "one additional objective" or "additional objectiveS". "Constrain", not "constraint". ok

L. 24: "THE caRamel algorithm belongs to THE. . ." ok

L. 26: "THE caRamel..." ok

Page 3:

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L. 2: I would say "The caRamel algorithm" ok

L. 16: "fRont" ok

L. 20: "each generation": does each of the 5 rules counts for one generation?

One generation is created by calling each of the five rules. So one rule is only a part of a generation.

Page 4:

L. 6: "this syntax". In addition, please remove the space after "caRamel" and before the parenthesis. ok

L. 9-10 "the minimization or maximization goal": from the way it is written, I was expecting a value. Actually, it is a Boolean used for saying if this is a maximization (minmax = TRUE) or not. I would suggest rephrasing. In addition, I think that the name of the argument, minmax, is not well chosen. minmax is ok if the choices are "min" and "max", but not if the choices are "TRUE" or "FALSE".

We will put this section as an appendix. We will take your renaming suggestion into account for the next version of the caRamel package.

L. 15: I would say "choice of a parallel or sequential computation" ok

L. 18: not clear. Which kind of managing?

The user can choose the number of parameters generated by each rule for a generation. For example, this number is set by default to 5 new sets generated by each rules at each generation, but the user may choose to give more weight to some rules.

L. 19: there are six elements when I tried it, but the last one (gpp) is not explained in the package.

We will add the description of gpp.

L. 23: I would say "of objective values", as otherwise we don't know if these are names or values. ok

Page 5:

L. 6: "an R vignette that gives" ok

L. 14, 15, 17: I would add a comma after accuracy, diversity, cardinality. ok

L. 20: please add ", which" after "(GS)" ok

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L. 21: please add a comma after "(HV)" and an hyphen in "volume-based" ok
L. 24: I would rather say "the R package `mco` ("Multiple Criteria Optimization", Mersmann et al., 2014)". Please also make sure in the whole manuscript that the package name is written as `mco`, not `MCO`. ok

Page 6:

L. 2: "with `THE Kursawe`. . .". In addition, I think it is necessary to introduce a bit what this function, is, what is its aim. I'm not familiar with it and I guess that some other hydrologists also are not.

We will add a short description of `Kursawe` function.

L. 4: "THE population size" ok

L. 5 and 8: "THE `caRamel` ..." ok

L. 10: double typo: "show that `caRamel`" ok

Page 7:

L. 11: maybe specify on which spatial unit the model is semi-distributed. In this example, the spatial discretization is based on an elevation zone approach is not used.

We will correct it in the text.

Page 8:

L. 2 then is the snow part of the model active?

No, the snow module is not activated in this example.

L. 8: define the `KGE` acronym. ok

L. 10: maybe replace "is the result of" with "reflects" ok

L. 16: here and everywhere else, I would write "parameter sets" with no `S` at parameter. ok

Page 9:

L. 4: "In the `mco`. . ." ok

L. 17: "optimizer`S`" and "get`S`" ok

L. 18-19: what is the meaning of reproducible? I don't get it. Reproducibility refers to the ability of one optimizer to give the same results in given conditions. In our case study, the optimization have been run 40 times to check if the results are reproducible.

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On Fig. 6c, the envelope with `mco` is much larger than the one with `caRamel`, which means that optimization results are more variable with `mco`.

Page 10:

L. 4: "provide", not "provides" ok

L. 5: "give", not "giving" ok

L. 6: I quite disagree regarding the "cel" parameter as especially for `mco`, the spread seems quite large on Fig. 7.

We were considering the distance between the first and third quartile that is quite narrow.

L. 13: any idea about how many parameter sets that represents?

857 for `caRamel` and 655 for `mco`.

Page 11:

L. 10: "in an R..." ok

L. 11: "THE result" ok

L. 14: "from THE `mco` R package. . ." ok

L. 18: "provided that" ok

L. 21: "as an R package" ok

Appendix A and B:

In the code, some spaces are randomly put before or after commas. That could be cleant. ok

Table 1: caption: "of THE `caRamel`. . ." ok

I have a couple of comments regarding the description of the main function of the package: - `nvar`: why not using the word parameter instead of variable? See the description of argument bounds, which uses the name "parameter" ok

- `minmax`: somehow it should appear that several values are possible (e.g. "whether the objectives are. . .") ok

- `func`: "the R objective function" ok

- `objnames`: "name`S`" ok

- `write_gen`: that would be much more logical to have a logical here instead of an

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integer

We will take that comment into account for the next version of the package.

- *func* and *funcinit*: these two arguments do not take characters but functions. If we enter "kursawe" it does not work, we have to put the name of the function. See FUN argument of *tapply* for instance. [ok](#)

Table 2: *ce_{tp}* is a "multiplicative" correction factor [ok](#)

References

Coron, L., Thirel, G., Delaigue, O., Perrin, C. and Andréassian, V. The Suite of Lumped GR Hydrological Models in an R package. *Environmental Modelling and Software*, 94, 166-171. DOI: 10.1016/j.envsoft.2017.05.002, 2017.

Coron, L., Delaigue, O., Thirel, G., Perrin, C. and Michel, C. *airGR*: Suite of GR Hydrological Models for Precipitation-Runoff Modelling. R package version 1.3.2.23. <https://CRAN.R-project.org/package=airGR>, 2019.

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