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Interactive Comment

Interactive comment on "RRAWFLOW: Rainfall-Response Aquifer and Watershed Flow Model (v1.11)" *by* A. J. Long

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Author responses to Anonymous Referee #3.

Referee comments are shown, followed by Author's responses (—-). Also, please see Author's additional comment with attached pdf showing actual changes made to the manuscript.

In this paper, a new code for convolution modeling of hydrological or mass transport response of hydrosystems is proposed. The code is written in R language and as such is made available for the wide increasing R-users community. The paper is very well written and organized, the methods and mathematics used for the modeling approach are well described and the rationale supporting the overall approach is very accurately discussed. The model introduces new interesting concepts such as the spline smoothing approach applied to the IRF in order to reduce over-fitting (hence reducing computation time as well). The paper is suitable and deserves publication in GMD, as it clearly is beneficial to the scientific hydrological community. However, the differences between the previous Long and Mahler (2013) paper should be clearly highlighted (technical description of the code, methodologies and approaches, applicability and versatility...).

—- Short answer: The author thanks the referee this helpful review. Redundancies with Long and Mahler (2013) have been either deleted, moved to an appendix, or summarized very briefly.

—- Long answer: The MS did not make it very clear that this is the first release of the RRAWFLOW code to the scientific and public communities. Long and Mahler (2013) presented it as a research model with no code or user's manual. The revised MS now clearly states in the abstract and introduction that the purpose of this paper is to present a new version of RRAWFLOW with added versatility, to make the code publicly available, and to guide users in its operation. Equations 1-5 have been moved to an appendix. This was necessary because specific variables in Eqs. 1-5 are referred to throughout the MS and are included in RRAWFLOW outputs, and the RRAWFLOW download contains a user's manual that cites all equations in this manuscript. To avoid confusion for the user, I feel it will be most helpful if all equations are contained in the body or the appendix. Eq. 6 (now Eq. 1) is left in the main body because (1) I added one term to show how the equilibrium datum is applied in groundwater models, and (2) it pertains to Fig. 1, which is new in this MS to help explain convolution conceptually, which people seem to have trouble with. The related text has been shortened. Time-variance options, although some were presented previously, need to be discussed briefly for the purpose of explaining the different RRAWFLOW settings and options referred to in Table 1. The new continually changing IRF scale function needs to be presented also. An additional feature that I have included since submitting the MS is the option to have RRAWFLOW calculate the wet and dry periods on the basis of

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the precipitation record, which includes options for two different methods. Previously, the user had to supply the wet and dry periods. Therefore, a short section (section 2.6) was added to describe how these options work and the associated RRAWFLOW settings.

p.5928, l.15: Maybe mention that such terms are sometimes used improperly since for instance the transfer function actually refers to the Fourier transform of the IRF and that other terms are related to continuous-time instead of discrete-time functions. —- Done

p.5928, l.20: I would remove these lines: I don't see the point of comparing convolution with spectral analysis. Convolution is one of many tools (like cross-correlation, autocorrelation, etc.) used in digital signal processing. —- Done

p.5931, l.10: Since this is a methodological paper, it would be better to briefly describe the method used for determining the IRF by model calibration as employed by the same author in Long and Mahler (2013).

—- The reference to Long and Mahler (2013) was in error here. This paper did not present any nonparametric IRFs.

p.5931, l.13-18: Fourier transform-based deconvolution induces over-fitting because of the spectral signature of errors. Do the author think that filtering out high frequencies in the Fourier space previous to inverse transform be a good alternative to the spline interpolation approach in order to smooth the IRF by removing oscillations related to Fourier transform of the errors? Wouldn't such a Fourier filtering approach also lead to a good and consistent estimation of the IRF?

—- Good point. Since different filters would produce different IRFs, many different filters might need to be tested, which would be another form of model calibration. This would be an interesting approach. To briefly address this idea, I inserted the following text: "Filtering the IRF in the frequency domain (i.e., transfer function; Smith, 2003) or smoothing the IRF in the time domain (Long and Derickson, 1999) are options for IRF

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estimation by Fourier analysis, which may require trial-and-error calibration."

p.5931, l.24: Since optimization is based on a very limited number of points and spline (or linear) interpolating functions are used afterward to assess ordinates other then control points, what would be the influence of the interpolation scheme used (different spline functions, spline vs linear interpolation) on the result of the modeling? Is there an appropriate minimum number of control points to consider?

—- Inserted text: "Trial and error generally is required to determine the optimum number of control points for a given application, and this number may be affected by the choice of a spline or linear interpolation. The minimum number of control points is two: at least one to define the non-zero part of the curve and one to define where the function becomes zero."

p.5935, l.5: Was 95% of the total area of the curve chosen arbitrarily or was it supported by some other criterion? —- It is arbitrary and mainly useful for comparison of different sites. The word "arbitrarily" was inserted into the sentence for clarification.

p.5938, l.12-16: There are lots of packages devoted to optimization in CRAN repositories. The RRAWFLOW program would benefit using them in the future instead of external software like PEST.

—- Text inserted: "RRAWFLOW is a stand-alone model, independent of PEST, and therefore can be used with any optimization routine. For example, optimization packages are available in the comprehensive R archive network (CRAN) that could be built seamlessly into RRAWFLOW, possibly in future versions."

p.5942, l.9-13: Could a threshold value of the ratio Eval/Ecal be proposed to assess overfitting? I understand overfitting may result from the choice of, say, a double-gamma instead of a single-gamma IFR. But what if the double-gamma makes more physical meaning owing to experiencing or knowledge about the site tested?

—- I like this idea of the Eval/Ecal ratio. Indeed more research could be done to evaluate such a threshold. Text inserted: “The ratio Eval/Ecal might be a useful metric for comparison of different models and possibly in setting the lengths of the calibration and validation periods. As in any model, this all should be considered in reference to a physical understanding of the system; e.g., two gamma functions might be consistent with two distinct permeability domains.”

p.5943, "code availability" section: Will the software be made available as a package through the comprehensive R archive network (CRAN)?

—- Not at this point. Text inserted: “The code is not yet available in CRAN but could be included in the future.”

Interactive comment on Geosci. Model Dev. Discuss., 7, 5919, 2014.

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