Hydrol. Earth Syst. Sci. Discuss., 10, C3046–C3048, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C3046/2013/


Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Approximate Bayesian Computation in hydrologic modeling: equifinality of formal and informal approaches" *by* M. Sadegh and J. A. Vrugt

**Anonymous Referee #2**

Received and published: 7 July 2013

Approximate Bayesian Computation in Hydrologic Modeling: Equifinality of Formal and Informal Approaches

HESS: Sadegh and Vrugt, 2013

Summary: This paper describes and compares ABC and GLUE next to each other. The paper is well written and I recommend publication if the authors thoroughly address the following comments.

1) Please do not claim that ABC is "introduced" in this paper. Your recently accepted paper in WRR "introduced" ABC for hydrological applications (Vrugt and Sadegh,



2013). It is fine to have some duplication (in fact, even 'needed' to understand the paper by itself), but I would be more explicit about the fact that the ABC method is already introduced. This paper for HESS has the nice feature of connecting ABC with GLUE. Yet, that is only mentioned at the bottom of the abstract and end of introduction. I would suggest to bring the connection with GLUE front and center in the HESS-paper to avoid a vague feeling that this is a repeat of the WRR-paper (which is not the case, I checked). Also maybe add on l.161 that this paper is also a follow up of Vrugt and Sadeg 2013, rather than just Vrugt et al (2008c).

2) Could you please address the following conceptual issue:

The traditional 'calibration' approaches aim at minimizing squared residuals (mean square errors, MSE). This paper instead minimizes differences between means (and standard deviations), i.e. summary statistics. However, the MSE is nothing else but a difference between means, plus some additional terms, including standard deviations (sigma). The additional information in the MSE is a correlation (r) between the obs and obs predictions.

MSE = sigma_obsˆ2 + sigma_modelˆ2 – 2.r.sigma_obs.sigma_model +( mean(obs)-mean(model))ˆ2

So, it comes as no surprise that with inclusion of more terms that are 'like' the MSE/likelihood function, the ABC method will become better. And it is also no surprise that the 'DREAM' (better 'formal Bayesian') results (table 4-5-6) yield a more accurate (lower RMSE) result and with less simulation uncertainty. The 'DREAM' –calibration simply included more constraints than the ABC-approach, leaving less wiggle room for the posterior parameter estimates. In short: I think that the comparison of the ABC and DREAM results could perhaps be improved by adding more constraints to the ABC-algorithm, so that is more 'like' the likelihood function used in DREAM: e.g. I think that it would be better to use the first 3 terms instead of (std(Y) – std(Y(\theta)) to do a fair comparison.

3) Text around Line 19: something is confusing dimension-wise. If n is not the number of time steps, but really the dimension of an observation vector (multiple obs) at one time step, then n cannot be used as the dimension of forcings (e.g. precip, ET) at one time step. The index t is used for time. Please clean up. Also: one system has one evolving state, consisting of multiple state variables, so line 19 should read 'x_0 signifies the initial state' (or state variables, not states). Similarly, take out the "(s)"at number 3 and 6 in Fig. 1. Finally, number "7" (observation error, mentioned on line 30) is not in the Figure 1 (also missing in the WRR paper).

4) Eq. 5: how about changing the '\rho'-symbol in a capital '\Delta'-symbol? '\rho' is often associated with correlation. (suggestion)

5) Case studies: could you please comment what to do if there is bias, rather than only random error, in either data or simulations? Would you simply inflate the epsilon?

6) Line 489: I like this bridging idea and would like to see it more stressed in the paper, but please correct the typo (cap – gap).

7) Last sentence and the use of 'DREAM' throughout the paper: it is confusing to think of ABC using simulations with DREAM (after presenting these methods apart in this paper).

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 4739, 2013.