Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-622-RC2, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "A reduced-order model for dual state-parameter geostatistical inversion" *by* Yu-Li Wang et al.

Anonymous Referee #2

Received and published: 23 January 2020

Dear authors,

I read with interest your submission to HESS. The work can potentially make significant advances in solving inverse problems in hydrogeology and its topic is relevant to the readership of HESS. A robust inversion algorithm is developed to automatically account for data errors by reducing the number of parameters (and therefore avoid over-fitting) using SVD. The new approach is also efficient enough so that the derivation of adjoint equations no longer necessary for large highly parameterized inverse models.

The presentation of this work (esp. the abstract and conclusion) needs considerable improvement. There are too many obvious English errors and illogical sentences (see partial list below). I recommend having someone editing the paper before the next submission. I agree with RC1 that the abstract needs to be rewritten and have key

terms defined. Key findings such as computational savings should be quantified in the abstract. The conclusion section failed to highlight its major contribution (e.g. the main contribution of this paper is not to account for subsurface heterogeneity!). Lastly, perhaps some flowchart summarizing the method will be helpful.

I will be pleased to see this work published in HESS but some major revisions are needed to improve its presentation.

Overall assessment:

The methods section is difficult to follow. A better approach would be, without losing generality, introduce hydraulic tomography and SSLE first and then go into the SVD of error covariances.

In the results section, there is no mention of how many leading eigenvalues (or

The issue with brick/regular/rectangular domain mentioned in the abstract and L119-126 doesn't seem to be entirely justified. Is the matrix manipulation method shown here applied to hydrology problems the first time? Can they be readily applied to existing methods listed in the above lines? How useful is the matrix manipulation to eliminate cells compared with more pragmatic approaches such as using a larger domain and then set inactive cells in a flow problem?

Specific comments:

Please use the HESS template without any modification for resubmission.

Pay attention to these errors, e.g.: + "approach stable" or "approach steady" or "are steady" + "unknow" + "as the result" + "numeric errors" + "a bunch of realizations"

I can't follow these sentences: e.g. most of the abstract, L153, 222

Consider putting some lengthy derivation in the appendix

Title, L339: the entire article has no mention of dual state-parameter, revise

L40: what does "prefer scale" mean? I also find this paragraph quite ambiguous and not justifying high-resolution subsurface characterization

L57: computationally

L63: Afterwards

L67: give details

L70-71: Use Big O notation for computational cost

L73: by how much

L73 onwards:

L77: the finite-difference approach

L79: takes advantage

L92-96: it's not good enough to just list the existing methods. an assessment of their characteristics/strengths/ weaknesses is needed. A table may be helpful.

L105: in practice

L108: specifically

L110-L118: Do you think modelling the measurement errors (as in ERT literature) is a more straightforward way to solve the problem? also, check out "Robust inversion in ERT"

L142: Add a method overview

L197 onwards: needs to introduce the error formulation... consider using curly brackets under parts of the equation to introduce terms such as W and R_{hh}

L280: Did you use the analytical solutions here?

L309: should specify which computation time refers to which regime

L311: Is it just a differencing scheme, why call it a perturbation approach?

L314 $g^{(r)}$: confusing symbol, used g as eigenvectors before. Use another symbol or font

L326-327, 335-336, section 2.5: This needs to be highlighted somehow! e.g. in a table and recapped in conclusions/abstracts

L328-336: Did you use this more accurate version here?

L340: how do you get this number?

L346: elegant?? do you mean the governing equation is linear or K does not depend on H?

L352: straightforward instead of easy

L411: in other words

L474: the increase in

L484: remove the before similar

L488: cite map – so that readers can know how the map is derived

L491: you mean deposits?

L493: you mean "collocated" instead of "in parallel"?

Fig 2 and 4: please mark which iteration is the used for the "best" iteration (in the caption or a vertical line in (a))

Fig 2 and 3, 4 and 5: Can't the modeller just saves all the outputs from the old algorithm and pick the best one?

Fig 8: R2=1.0 and y=X trendline– too good to be true? Please double-check or add digits

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-622, 2020.