Hydrology and
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Sciences
Discussions

Interactive comment on "Global Sensitivity Analysis and Adaptive Stochastic Sampling of a Subsurface-Flow Model Using Active Subspaces" *by* Daniel Erdal and Olaf A. Cirpka

Anonymous Referee #1

Received and published: 3 May 2019

In this paper, the authors used active subspace for global sensitivity analysis and stochastic sampling of a subsurface-flow model. The topic is interesting and suitable for this journal. The adopted method also seems to be efficient and effective. However, some improvements are still required for final publication.

1. There are many useful methods for global sensitivity analysis as stated by the authors in the introduction. Why the authors use the activity score (equation (8))? Can this metric provide more reasonable results for the studied problem than other metrics? Please make an explanation.

2. The authors use active subspace to construct a meta-model in order to select the be-

havioral samples with a lower computational cost. In this work, only 2 active variables are used to construct the meta-model. Why do the authors use 2 active variables? As my understanding, more active variables will make a better meta-model. Do the authors think that 2 active variables are enough to construct an accurate meta-model? Please make an explanation.

3. The authors use meta-model to select behavioral samples. Since the meta-model only is an approximation of the real model, an error will arise when using meta-model. To construct the meta-model within active subspace, the authors first need to construct an active subspace. This requires the gradients of the model output with respect to the input parameters, which is a computational-demanding task. The authors fit a polynomial to approximate the real model, then obtain the gradient based on the polynomial. This approximation will cause another error. That is to say, there are two kinds of errors caused by approximation (meta-model) in the whole procedure. Since these two kinds of errors are not independent, the final error may be amplified. It will be better to analyze how these two errors will affect the final error of results.

4. For the meta-model within active subspace, the authors use third-order polynomial. Why do the authors use third-order? Is third-order enough for the meta-model? Some explanations should be given to convince readers.

5. In page 7(step 2), why do the authors construct an active subspace for each behavioral target? For a scaler model output, there is only one active subspace. Different behavioral targets can be defined based on the same model output. And in this situation, it will be not necessary to construct an active subspace for each behavioral target. I think constructing an active subspace for each model output will be reasonable.

6. In page 7(step 5), the accepted sample based on the meta-model is used for running the real model and obtain the prediction. Since the meta-model only is an approximation of the real model, the accepted samples based on the meta-model may not be really accepted by the real model. These samples should be non-behavioral samples.

Do the authors still use these sample for global sensitivity analysis?

7. In page 8(step7), all the 500 initial samples are accepted. Since the initial samples are randomly generated without selection, some of them will be non-behavioral samples. Thus, using these samples for global sensitivity analysis will be unreasonable.

8. In page 13, the meta-model selects 4533 samples from 10000 samples. In comparison, only 588 samples from 10000 samples are selected based on the real model. Does this mean the meta-model is not accurate to approximate the real model? Or, do the authors use different criterions to select the behavioral samples for different cases? In addition, the results are based on the behavioral samples obtained by the meta-model. Since there is a significant difference between the obtained behavioral sample by meta-model and the real model, can we really trust the results based on the meta-model? Therefore, a reference result obtained only based on the real model can be provided for comparison.

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