Reply to Short Comment of Gabriele Baroni
Review received and published: 23 Aug 2020

Dear Gabriele,

Thanks a lot for your suggestion. We will reply below in detail to your comments. Your comments are *italic*; our replies are highlighted **bold**. The **line numbers in red** are referring to the revised draft.

Best regards,
Julie, James, and Bryan

Dear Juliane, dear Authors,
I have really appreciated that your study has been motivated by, among others, one of my papers (Baroni and Tarantola, 2014). I also think your manuscript can be a nice contribution to the literature, but I leave to the official Reviewers to judge with more specific comments. When reading this preprint, however, I found the need to add this short comment to clarify the terminology. I hope this will also help to strengthen your work.
Sincerely,
Gabriele Baroni

Comments

In this study, you have introduced the use of weights that can take on non-integer values to account for model structures in the analysis. As you correctly cited I used, in contrast, discrete integer values in Baroni and Tarantola (2014). However, I find important to underline also here that this "trick" has been previously used. I think that I had properly acknowledged that in my paper and I paste the reference below for sake of clarity:

"The use, at step 5 of the framework, of a discrete scalar factor of the size of the realizations generated, enables us to extend the GSA also to non-scalar sources of uncertainty. This approach was introduced by Crosetto and Tarantola (2001), who proposed the use of a sensitivity analysis of a binary input to 'switch' the uncertainties of a rainfall intensity map on and off at the same rate (i.e. for N/2 runs, the switch is set to off and for the remaining N/2 runs it is set to on), allowing their relative importance to be determined. The same approach was then improved by Lilburne et al. (2003) and Lilburne and Tarantola (2009) who explicitly introduced the discrete uniform distribution associated to the different realizations of each specific source of uncertainty as considered in this framework."

Additional discussion on the use of discrete random variables can be found also in Plischke et al. (2013).

For this reason, I found misleading to read in your manuscript that you compare your xSSA method with "Baroni method". Instead, I suggest using something like "continuous weights method" vs. "discrete values method". In my opinion this would better describe what you are comparing.

We agree with the reviewer that this method was used before and the introduced as a novel framework for sensitivity analyses by Baroni and Tarantola (2014). To avoid confusion and acknowledge also previous attempts to use binary or discrete random variables for sensitivity analyses we now use the term "discrete values method" (DVM) throughout the manuscript instead of "Baroni method". We however continue to refer to the proposed method as the xSSA method as it comprises not only of the "continuous weights" but also the grouping of variables. We made the following adjustment in the introduction:

line 50 ff. **To date, there have been limited attempts to simultaneously estimate model parameter, input, and structural sensitivities. One notable attempt is introduced by Baroni and Tarantola (2014) using a Sobol' sensitivity analysis based on grouped parameter. In that study, groups of soil and crop parameters, the number of soil layers, and a group of parameters to perturb inputs are investigated. These groups of parameters are pre-sampled and a finite set of parameters for each of the four groups is chosen and each set is enumerated. The sensitivity analysis is then based on those enumerated sets. This means, rather than sampling each individual parameter like in a classic Sobol' analysis, an integer for each group acting as a hyper-parameter is sampled. The model is then run with the associated pre-sampled parameter set. While the approach may be generally applicable to arbitrary structural differences, in their testing, Baroni and Tarantola (2014) varied only in how the model was internally discretized (i.e., in the number of soil layers). The soil and crop parameters were always used for the same soil and crop process. The major limitation of this method is, however, that individual parameters need to be mutually exclusive and can only be associated to one type of uncertainty. The method hence limits the groups that can be defined, for instance, overlapping group definitions are not possible. The method will be referred to as "discrete values method (DVM)" in the following and will be contrasted to the method developed here to examine this limitation in more detail.**

We also replaced "Baroni method" everywhere else in the manuscript by "discrete values method (DVM)".

References

Baroni, G. and Tarantola, S.: A General Probabilistic Framework for uncertainty and global sensitivity analysis of deterministic models: A hydrological case study, Environmental Modelling & Software, 51, 26–34, 2014.

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Lilburne, L. R., Webb, T. H., and Francis, G. S.: Relative effect of climate, soil, and management on risk of nitrate leaching under wheat production in Canterbury, New Zealand, Australian Journal of Soil Research, 41, 699–709, 2003.

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