

Interactive comment on “Technical note: Method of Morris effectively reduces the computational demands of global sensitivity analysis for distributed watershed models” by J. D. Herman et al.

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Received and published: 30 May 2013

This comment contains author responses to Anonymous Referee 1. Author responses are shown below in plain text. Referee comments will be shown in italicized font.

Interesting work!. Good introduction, good methodology, sound conclusions with new insights about the potential of Morris method to estimate parameters in large models with many inputs.

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Thank you for your time and insight to improve the clarity of our work.

Anyway, one major comment to improve the quality of the paper, is the sampling method used to apply the Morris method (as it is not commented in the paper). In Campolongo et al., 2007, the issue of the necessity to improve the sampling matrix generation is highlighted. Such a method has gone under major revision in later works: Ruano et al. 2012. An improved sampling strategy based on trajectory design for application of the Morris method to systems with many input factors. Environmental Modelling Software, 37, pp. 103 – 109; Campolongo et al. (Campolongo, Saltelli, and Cariboni. From screening to quantitative sensitivity analysis. A unified approach. Computer Physics Communications, 182 (4); 978-988, 2011) and the authors should at least be aware of these improvements.

The reviewer has raised an important issue regarding sampling for sensitivity analysis of highly parameterized models. In this study, we have applied the traditional sampling approach proposed by Morris (1991), in which trajectories through the parameter space are generated by randomly perturbing one factor at a time. The improvement of Campolongo et al. (2007) involves generating hundreds of such trajectories, and choosing a subset of these which maximize the coverage of the parameter space; Campolongo et al. (2011) provide a radial sampling design method with similar intent. We agree that coverage of the parameter space is a critical issue for models with large numbers of parameters, and we will be sure to include a discussion of these potential improvements in our revised manuscript.

Our results in this technical note indicate that using the sampling strategy of Morris, we have captured a sufficient portion of the input space to reproduce the results of much larger Sobol analyses ($N = 6,000$). While there is room for improvement of the sampling method in future work, we do not believe our choice of sampling method has adversely affected the quality of results presented in this study.

Another comment is that I do not agree that no differences in sensitivity information are

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obtained when increasing the Morris sample size. I agree that the resulting most sensitive and the non-sensitive there is no difference, but Figure 5 shows that as the sample size is increased the relationship between Morris and Sobol for the influential parameters becomes more lineal (of course there is non-linearity, but at least improves....).

Our results show that increasing the sample size of the method of Morris in this experiment between 20 and 100 provides very little improvement in the results. Figure 5 indicates that the nonlinear Spearman correlation coefficient only increases from $\rho = 0.885$ to $\rho = 0.898$ between these two sample sizes; considering the five-fold increase in computing required, we do not believe this is a significant improvement. The reviewer is correct that there is technically a difference in sensitivity information between sample sizes, so we will carefully change wording relating to this issue in the revised manuscript.

Morris screening no distinguish between nonlinearity or/and interaction between parameters, when are influential, but at least when the Morris graph method is used, also information about this can be obtained. So, one option is to include the Morris graph in order to see this information regarding the influential parameters (high/low variance) and compared to Sobol results.

If we understand the issue correctly, the reviewer makes a valuable suggestion to investigate the variance of elementary effects returned by the method of Morris, as this information can often point to sources of nonlinearity and parameter interaction in the model. While we do not believe this information to be central to the narrative of this short technical note, we would be happy to provide such plots as supplementary material at the time of revision.

Minor comments: -typing error page 4283, line 11: "simulation" - Figure 3 caption, is too long, relevant results are commented in the caption. At least, the most sensitive parameters must be further explained their role in the model in order to better interpret the results. - Page 4286, line 7, parameter UZK corresponds more to the headwaters

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than outlet. - Include how do you scaled the EE. - why in Figure 5, Morris sensitive measurement is not higher than 0.1? Figure 4 shows values up to 1.

Thank you for your comments; we will be sure to address these in the revision. The method of Morris sensitivity values are normalized to the range [0, 1] to avoid confusion, because the Morris values do not have a direct quantitative interpretation as, for example, a percentage of model variance as Sobol does. The maximum sensitivity value is simply mapped to a value of 1 in Figure 4. On the other hand, the Morris values in Figure 5 have not been normalized, and the raw values are shown. We will correct this issue for the revision to ensure that Figures 4 and 5 are consistently scaled.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 4275, 2013.

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