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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Assessing parameter importance of the Common Land Model based on qualitative and quantitative sensitivity analysis" *by* J. D. Li et al.

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Comment: Introduction: I think the article could better review the existing studies that compared sensitivity analysis methods in the case of complex models, in environmental fields or others. Indeed, the authors only mention a few comparisons, but there are many other existing ones (Patil and Frey, 2004; Ravalico et al., 2005; Pappenberger et al., 2008; Confalonieri et al., 2010; Massmann and Holzmann, 2012; Neumann, 2012; Sun et al., 2012, to name but a few). Which insights are provided by these previous comparisons on the relative merits of sensitivity analysis methods? Are some of them more reliable than others? Are results from these previous comparisons all in agree-

ment? This discussion could provide a more general state-of-the-art on performance of sensitivity analysis methods. The studies analysed could be presented in a table to give a better overview of these past comparisons (reference, tested methods, target model, number of parameters, target variables, case study, main conclusions, etc.).

Response: Thank you for suggestion. We have added the following introduction in page 3, line 61:

Therefore, for a specific problem, choosing which kind of SA methods is very important. In recent decades, there are several comparisons of different SA methods, of which seven examples are shown in Table 1. We can see that the researchers got different conclusions: some suggested the quantitative SA methods are more reliable, some held that the qualitative SA methods can get consistent results with the quantitative methods; others supposed that applying multiple SA methods was expected to lead to more robust conclusions. The difference of those comparisons implies that more works are needed to answer how to choose the most appropriate SA method. Table 1 we added is shown in the appendix.

Comment: Methods: The presentation of methods is interesting but it may be interesting to shortly discuss the existing applications of each of them to complex models (see e.g. Nossent et al., 2011; Zhang et al., 2013, for the Sobol's method). This could give some information of the known applicability/performance of these methods to such complex models.

Response: The following discussion of MARS method is added in page 7, line141 :

The MARS method is actually a surrogate-model method. Shahsavani et al. (2010) showed that MARS provides acceptable estimates of total sensitivity indices at a much lower cost than using only runs of the original model.

The following discussion of Morris method is added in page 9, line 177:

Because of its small computational demands, Morris method has been widely applied.

Herman et al. (2013) demonstrated that it was able to correctly identify sensitive and insensitive parameters for a highly parameterized, spatially distributed watershed model with 300 times fewer model evaluations than the Sobol' method.

The following discussion of Sobol' method is added in page 10, line 196:

For example, Rosolem et al. (2012) used 45,000 samples to the Sobol' sensitivity indices of 42 parameters in the Simple Biosphere 3 (SiB3) model. Zhang et al. (2013) used 60,000 model runs to study the sensitivities of 28 parameters in the Soil and Water Assessment Tool (SWAT) model through Sobol' method.

Comment: Page 2254, Line 3: Give basin size.

Response: The following introduction of basin area is added in page 12, line 247:

The Heihe river basin, the second largest inland river basin in the arid region of northwest China, is located between 96°42'-102°00'E and 37°41'-42°42'N, and covers an area of approximately 130,000 km2. The Heihe river basin, whose altitude varies approximately from 0 to 5500m, is covered by a variety of land use types, including desert, farmland, forest, grassland, snow cap, etc. Therefore, it is an ideal region for the study of LSM. In this paper, A'rou observation station, which is located at the upstream of Heihe river basin, is choosen for the study area. The results of SA methods intercomparison will be helpful for following up researches of the whole region.

Comment: Conclusion: The authors could better discuss to which extent their own results corroborate or contradict the results of previous comparisons of sensitivity analysis methods. If there are differences, how can they be interpreted? This could also help better discussing the generality of the conclusions provided here (would the relative merits of the tested methods be the same if another model had been used? If another case study area had been selected?)

Response: The following discussion is added in the conclusion, page 20, line 422:

By using meteorological and land surface observation data in A'rou, Heihe of Northwest

China, this study demonstrates the feasibility of employing different qualitative global SA methods to find the most important parameters in a complex model, which is similar with Massmann and Holzmann (2012). Though different methods are compared, we confirmed that global SA methods are more suitable for complex models to screen out the most sensitive parameters from the insensitive ones. Because there exist some differences among the rank of screened parameters given by different SA methods, we suggest that multiple SA methods should be applied for a complex problem, which is also supported by Neumann (2012).

The following sentence is added in, page 21, line 428:

For a 40-parameter CoLM, we were able to screen out the most important parameters using only about 400 samples, which is similar with Confalonieri et al. (2010).

Comment: Table 1: I did not understand the definition of P7. Why mentioning "between 0 and 1" for P13 whereas the range is specified in the last column.

Response: The physical meaning of P7 is changed to "a factor for controlling whether water is impermeable". The words "between 0 and 1" are deleted.

Comment: Table 5: What deltaz refers to in the caption?

Response: Sorry for my negligence. Deltaz is the difference of the depth of two layers, which is not contained in the main body.

Comment: Table 1: An extra column could be added in the table to mention the category (canopy, soil, snow, as mentioned in the text, page 2253, line 7) to which each parameter pertains. Tables 3 and 4 could be merged.

Comments:

Page 2245, Line 22: "Saltelli et"

Page 2245, Line 23: "relatively" (?)

Page 2251, Line 23: “response”

Response: Thank you for the suggestion. These suggestions are all accepted, and the corresponding changes have been made in the main body.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/10/C2604/2013/hessd-10-C2604-2013-supplement.zip

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 2243, 2013.

Appendix

Author and year	Model	Number of paramet.	Conclusions
Patil and Frey (2004)	food safety risk assessment model	9	ANOVA, mutual information index, and scatter plots were expected to be more robust than others methods.
Ravalico et al. (2005)	integrated assessment model of the Namoi River	11	FAST method was shown to meet the criteria most effectively.
Pappenberger et al. (2008)	flood inundation model	6	Different methods leaded to completely different result.
Confalonieri et al. (2010)	water accounting rice Model,	11	Morris method, the simplest among the SA methods used, produced results comparable to those obtained by methods more computationally expensive.
Massmann and Holzmann (2012)	rainfall–runoff model	11	The mutual entropy and the RSA methods give more robust result than Sobol's method.
Neumann (2012)	micropollutant degradation model	10	Applying multiple SA methods with multiple objectives was expected to lead to more robust conclusions.
Neumann (2012)	water quality model	6	RSA (regional sensitivity analysis) was more appropriate for complex models where system nonlinearities and parameter interactions were more likely to be important

Fig. 1.