Hydrol. Earth Syst. Sci. Discuss., 10, C2610–C2617, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C2610/2013/

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: 1) In my opinion, it is a little confusing to use the terms "qualitative" and "quantitative" to categorize the two groups of SA methods. I think all of them are quantitative with quantitative measures of sensitivity, either locally or globally, based on gradient or interpreted output variability. If one cares about the overall uncertainty of output simulations, it is important to use global SA by evaluating the contributions of the explanatory variables (e.g., porosity, b) to the overall variability of simulation outputs (e.g., ïňĆuxes). However, if it is important to understand the parameter signiïňĄcance for extreme events, or the input-output relationships are nonlinear (e.g., parameter p1

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may have negligible impact on simulated ïňĆuxes in the lower range, but dominate in the upper range), then local gradient SA is helpful or even critical.

Response: We admit that both “qualitative” and “quantitative” SA methods give quantitative measures of sensitivity, but the measures are designed in different paradigms. For “qualitative” methods, the sensitivity measures are heuristic “scores”, such as GCV in MARS and number of splits in sum-of-tree. Such scores can qualitatively give a conceptual “feeling” of the magnitude of sensitivity, but the “metric” of sensitive scores is different from the output variable. While for “quantitative” methods, the result has identical “metric” with the output variable itself. For example, the Sobol’ sensitivity analysis can give the variance of the output variable.

We add the following paragraph in section 1 introduction, page 3, line57.

Qualitative methods provide a heuristic score to intuitively represent the relative sensitivity of parameters, while quantitative methods tell how sensitive the parameter is by computing the impact of the parameter on the total variance of model output.

About local and global sensitivity analysis, we add following discussions in page 16, line333.

The possible reason is that the local behavior near one specific parameter set is different from the global behavior.

In page 18, line 367

In summary, global SA methods, SOT, MARS, DT and Morris methods, are effective to screen the most sensitive parameters reliably with only 400 samples for a 40-parameters problem, even though DT may commit type II error. Local gradient SA is helpful if when we are interested in particular events or special parameter set, but it might give misleading result when we care about the global behavior.

Comment: 2) It is important to discuss, or at least mention the impact of the initial parameter ranges (i.e., input uncertainty). Moreover, sensitivity is not equivalent to

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contribution. The response variable y can be the most sensitive to a parameter xi, that is dy/dxi is large, but if the uncertainty range for xi is narrow, we expect to have little contribution (interpreted variance/variability) of xi to the variations of y, and therefore xi is not important given the quantitative measure. A few more discussions in the text are helpful.

Response: The following discussion about parameter ranges are added in page 12, line 231.

Note that the initial parameter ranges may have significant influence to the result of sensitivity analysis. For example, y = (a2+b)x where the range of input 'x' and parameter 'b' are both [0,1]. Obviously, parameter 'a' is sensitive when the absolute value of 'a' is very large and insensitive when 'a' is close to zero. The initial parameter ranges must be carefully selected and the analysis result may be valid only for these ranges.

Furthermore, the influence of initial parameter ranges is also one possible reason to explain the question in Page 2253, line 11-12, as shown below.

Comment: 3) The conclusions might be site-speciïňĄc. It is interesting to study, if possible, a few watersheds with different ïňĄeld/climate conditions.

Response: Thank you for your suggestion! When we were working on this paper we only got EC data of Arou station. Now we have collected additional data from four flux towers and also atmospheric forcing data of the whole basin. We are going to carry out multi-station and regional simulation and sensitivity analysis in follow-up research.

Comment: Page 2249, line 23: it is only true when people are perturbing each variable/dimension at only two levels, with only a single baseline case for comparison.

Response: It needs to be explained from the principle of delta test method. Let Y=F(X)= F(X_1,âŃŕ,X_m)+ε, the delta test method will consider the variable subset SâŁĘ{X_1,âŃŕ,X_m }. For example, if X=(X_1,X_2,X_3), the delta test will consider {X_1 },{X_2 },{X_3 },{X_1,X_2 },{X_1,X_3 },{X_2,X_3 },{X_1,X_2,X_3} The total num-

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ber of the subset is 23-1. Thus, for 40 variables, the number of possible subsets is 240-1.

Comment: Page 2251, line 8: equation (5) does not have quadratic terms? Nonlinearity are/cannot be considered?

Response: For the limitation of this paper, we didn't give a comprehensive introduction of Sobol' sensitivity analysis. Sobol' sensitivity analysis can consider nonlinearity. For more nonlinear examples please refer to the book by [Saltelli et al., 2000]. In equation 5, the terms are not "linear" or "quadratic" but different order of effects given by variance decomposition. S_i is main effect of parameter i, S_ij is interaction effect between parameter i and j. etc.

Comment: Page 2253, line 11-12: the ranges are for all types of canopy/soil/snow types -> the ranges might be too wide to be used for a single site?

Response: The reviewer has raised an interesting concern. When we determine the initial parameter ranges, there are two choices: 1) use ranges for all possible types, as we did in this paper; 2) initialize parameter values from canopy/soil/snow types and slightly adjust them with small multipliers. Because the first choice is similar to replacing the land use/land cover with another type (which is a widely used paradigm in sensitivity research of land surface modeling) and the ranges of the second choice are determined subjectively, we finally used the first one.

Comment: Page 2254, line 23: it is nice to conducted low-cost parameter screening before more expensive quantitative evaluations of parameter contributions. But again I don't prefer the term "qualitative".

Response: Please refer to the response to comment (1).

Comment: Page 2257, line 5: inconsistencies between the SA methods are expected for a single site study, since they focus on different aspects of parameter sensitivities/contributions. Need to be careful in making statements such as "a method is not

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good since it is different from others".

Response: Thank you for your suggestion. We revised the discussion in this paragraph:

Page 16, line 329

SOT, MARS and Morris methods got similar results for the most sensitive parameters, 'Can reliably identify' is changed to 'got similar results for'

Page 16, line 334

'DT can always identify the most sensitive parameters, but provide uncertain results for medium sensitive parameters' is changed to 'The most sensitive parameters given by DT are similar with other methods, but results for medium sensitive parameters are significantly different'

Comment: Page 2260, line 9-13: add a few bullets on input uncertainty, nonlinearity, and nonuniqueness issues.

Response: Thank you for your suggestion. We added the following sentence in page 20, line 407.

(4) input uncertainty caused by observation error may have non-ignorable influence to the sensitivity analysis; (5) screening the sensitive parameters for a complex model may be a non-uniqueness issues.

Comment: Page 2245, line 21-22: "identify" a subset among a group, or "differentiate" a subset from another subset. So it might be better to use "differentiate"

Response: Thank you for your suggestion, but we think "identify" is more suitable in this study. If we have red balls and blue balls, we can say "differentiate the red balls from the blue ones", because there is strict difference between the kinds of balls. However, for a parameter screening problem, there are most sensitive parameters, medium sensitive ones and most insensitive ones. We need to confirm whether a medium sensitive

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parameter will be screened out, so “identify” may be better.

Comment: Page 2251, line 23: explain a little more on how a response surface model was devel- oped. Consistency or convergence of such a model is another issue associated with parameter dimensionality.

Response: The following introduction about response surface model is added in page 10, line 203. The respond surface model here is constructed by the MARS method, which has been introduced in section 2.3.

Comment: Page 2257, line 25: “training and testing errors” need a few more explanations here.

Response: The following introduction about training and testing errors is added in page 17, line 347.

The training error is computed by the training samples which are used to construct the respond surface, while the testing error is computed by the other samples.

Comment: Page 2258, line 27: the sentence is to be revised. Theoretically, space will be filled with adequate number of samples, right?

Response: The sentence has been deleted. However, Morris method is not space filling indeed. It can be explained by the principle of Morris one-at-a-time sampling design. For a two-variables problem, if p value is set to 4, and âŰş is set to 2/(p-1)=2/3, the samples will be got as the following figure. Thus, no matter how many samples we get, if p and âŰş are unchanged, we will get only repeated samples. (see fig 1)

Comments:

Page 2244, line 20: consistence-> consistency

Page 2244, line 24: “. . . a LSM. . .” should be “. . . an LSM. . .”

Page 2245, line 13: suggest to replace 10s and 100s with O(10) and O(100), respec-

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tively

Page 2245, line 28-29: “(hundreds of fewer)” and (“tens of thousands or even more”). Remove. “hundreds” is not necessary a small number, it is dependent on the dimensionality of input parameter space as well as nonlinearity/nonuniqueness of input-output relationships.

Page 2253, line 7: “3” -> “three”. The small numbers, such as whole numbers smaller than ten, should be spelled out. There are many other occurrences.

Page 2253, line 11-12: use plural forms for “range” and “bound”. Duplicate word“types”.

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

References: Saltelli, A., K. Chan, and E. M. Scott (2000), Sensitivity Analysis, Wiley, New York, USA.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/10/C2610/2013/hessd-10-C2610-2013-supplement.zip

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

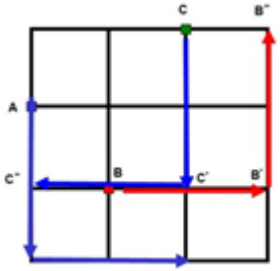

Fig. 1.

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