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Geoscientific Model Development Discussions

Interactive comment on "Fast sensitivity analysis methods for computationally expensive models with multidimensional output" *by* Edmund Ryan et al.

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Reviewer's comment #1: Page 4, lines 1-6: I think local sensitivity can be described better here. In this case the sensitivity is only analyzed along the nonlinear trajectories (locality). So the model is still nonlinear, the linearity is assumed for the perturbation.

Author's response #1: Okay, I'll try to improve the wording here. Changes to be made in manuscript: I will update the description of the local sensitivity analysis on page 4 to reflect more closely with your comment.

Reviewer's comment #2: Page 4, lines 7-12: I am not sure how thorough this analysis

can be conceived. Depending on the community, people call sensitivity analysis either global or local implicitly. I would argue that this should be discussed in the analysis of the results as well.

Author's response #2: I understand your point, however the purpose of the mentioning of local sensitivity analysis was to lead into talking about global sensitivity analysis. The purpose of this paper is not to discuss the merits of local versus global. If the mentioning of local versus global sensitivity may cause controversy I can delete any mention of local sensitivity analysis entirely. In fact, this might be better. Changes to be made in manuscript: I will delete all mention of local sensitivity analysis in the introduction. I will introduce global sensitivity analysis in a slightly different way.

Reviewer's comment #3: Page 6, lines 10-15: Calibrating the emulator may not be a trivial task especially for a global search. This is an element that needs to be discussed in any case.

Author's response #3: The page numbers and line numbers don't seem to match with you comment. I take your point that calibrating the emulator may not seem trivial, but with a small number of inputs and a scalar output (remember, we build a separate emulator for every point in the output space) it is actually quite simple. In the DICE-Kriging R package, maximum likelihood is used. This a common approach. Changes to be made in manuscript: In the 'Gaussian Process Emulators' part of the Methods section, I will add detail that explains how the emulator parameters are estimated.

Reviewer's comment #4: Page 16, line 17: an RËĘ2 of 0.97 to 0.99 is quite high. This may be an indication of a mostly linear system (necessary but not sufiňĄcient). Have the authors looked at this aspect is some detail?

Author's response #4: I'm not sure I understand this comment. The Rˆ2 value is a measure of how well the emulator outputs agree with the chemistry model outputs corresponding to the validation inputs. There are other metrics than can be used (e.g. AIC). Using Rˆ2 on its own is not wise, which is why I also give the median absolute

difference value and I also graphically show the differences (Fig. 2). Changes to be made in manuscript: Since I don't entirely understand the comment, I don't think there's anything to change.

Reviewer's comment #5: Figure S3 could beneïňĄt from adjusting the colormap

Author's response #5: Can you be more specific here? Do you mean that the colormap scale should not go as high as 65%? I purposely wanted the colormap scale to be consistent for all maps of the sensitivity indices to make it easier to compare different maps. For example, if I want to compare figure S3 with figure S4 I don't need to look at the scale to do this – I can just compare the amount of yellow versus blue in each figure. If the colormap scale went up to for example 20% in figure S3, yellow areas in figure S3 would not correspond to similar SI values as the yellow areas in figure S4. For comparison purposes, it is therefore far easier and less hassle if the colormap scales have the same min and max. Changes to be made in manuscript: I don't think there's anything to change.

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