Note: All changes in the manuscript are shown in bold.

Anonymous Referee #3

General comments:

The authors have presented a study of a local sensitivity analysis in the barycentric coordinate system. The proposed methodology is applied to the pedotransfer functions (PTF) developed by Rawls and Brakensiek and further on the TOPLATS model. It provides a coherent methodology for a sensitivity analysis of models based on compositional data. The case study raises awarness of the existence of regions where a model is especially sensitive to data quality.

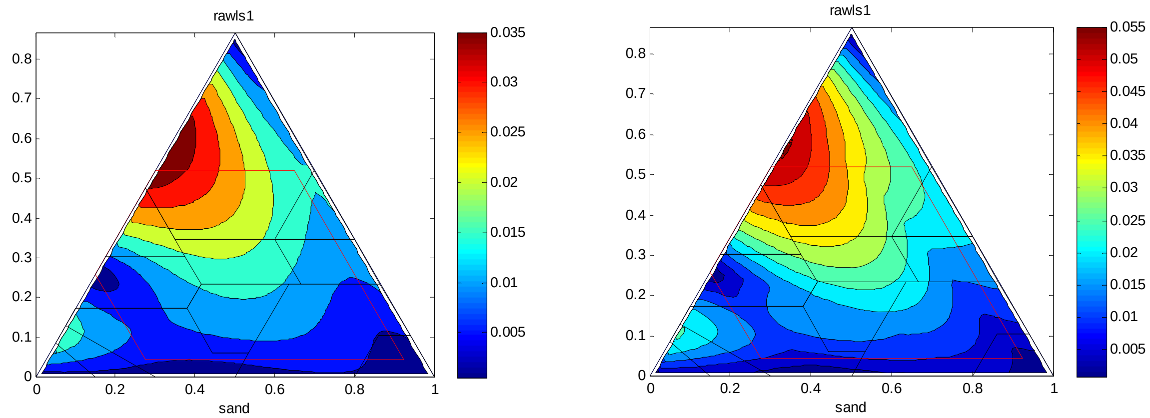
The study is well addressed and as the proposed methodology is described in detail, it can be easily implemented in other studies. However, a few issues, concerning i.e. perturbation of a parameter space and limitation of methods used in the presented case study, have to be revised.

1. *The weakest part of the article refers to the choice of "the perturbation factor". The local sensitivity index is computed on the basis of approximated function derivatives. The approximation is done with the use of the finite difference method and the perturbation factor determines its step size. The increment for the finite difference method is computed in the following way (page 8852, line 25): x _ (1 _ _), where x stands for parameter composition, _ perturbation factor and _ denotes scalar multiplication in a simplex domain. Such a formulation is correct (with the restriction in line 4-5, page 8856), if considered in a local scale, i.e. for each point we can find a _ value that minimizes eq. 9. However, the problem is that authors use one _ value for a whole parameter space and increment used in a finite difference schema depends on the distance from barycenter p0 – that is mentioned on page 8853, point 2 and page 8856.*

   As a result the incremental step is more or less accidental, which might affect the overall analysis (i.e. the author's reference in line 14, page 8845). For smooth, linear problems such an approach might be suitable; however the analysis performed in the section 3.1 suggests that it does not apply to the PTF – fig. 4 shows how the derivative approximation is sensitive to incremental step. The problem is serious, as all sensitivity hot-spots were localized near a simplex border, where the increment is biggest and a reader might be unsure if it is not caused by the applied perturbation technique.

   It has to be noted that the problem of perturbation factor covers only a small portion of the proposed methodology; however the impact of the variable increment on the result should be investigated or eliminated.

   - There are two possibilities to perturb a parameter: either with an absolute perturbation or with a relative perturbation. In the former case, the base value of the parameter is incremented (or decreased) with a fixed value, e.g. 0.01, such that dx=0.01. This means that independent of the distance from the baricenter, each textural composition is changed with 0.01, or stated otherwise, the distance between the base texture and its perturbed textures is always 0.01. The result of the SA with absolute perturbation is illustrated in Figure 4a for the parameter θ_s. In the latter case, the base value of the parameter is incremented (or decreased) with a variable amount, depending on the distance from the baricenter. The change in parameter value is calculated as $dx=\xi * x$ (e.g. ξ=0.01), which means that the further away from the baricenter, the larger the change in the textural composition (see Figure 5). The result of the SA with relative perturbation is illustrated in Figure 4b for the parameter θ_s. In this study, we have chosen to perform a relative perturbation, in analogy with perturbation of a non-compositional parameter. The standard practice is to choose a fixed perturbation factor (often not optimized) and to change the parameter values accordingly. This implies that if the parameter takes a high value, the induced change is also high. In this perspective, the perturbation in the simplex is an extension of the standard practice in the Euclidean space. Moreover, comparison between the result obtained with relative and absolute perturbation shows that both approaches result in the same sensitivity pattern. Therefore, the choice of changing textural values relative to their position in the texture triangle (more extreme textures are more disturbed) seemed straightforward.



(a) (b)

Figure 1: Sensitivity of θs w.r.t. soil texture as a result of absolute perturbation (a) and as a result of relative perturbation (b).

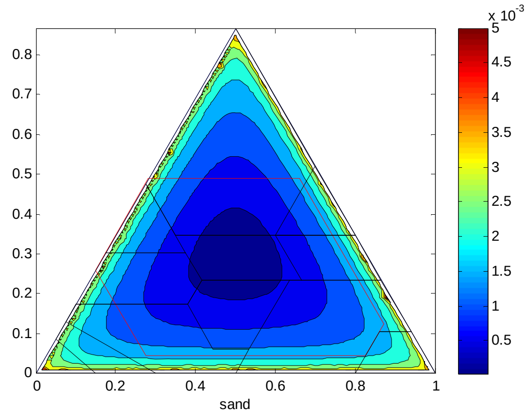


Figure 2: Induced change in soil texture as a function of the distance from the baricenter

- It is true that, ideally, the perturbation factor should be a function of the location in the texture triangle (as mentioned in the manuscript). We performed a continuous optimization on the texture triangle in order to get a correct idea of how the optimal perturbation factor behaves. The result of this experiment is shown in Figure 6. As can be seen from the figure, there is no clear trend in the value of ξ. Near the clay and silt axis, the relative value of the perturbation factor is usually lower than in the central part of the triangle, but the pattern is not very consistent. So we can argue that only for textures near the borders of the ternary plot, using the constant value for ξ of 10^{-2} might affect the overall sensitivity analysis. Furthermore, if the perturbation factor should be varied as a function of the soil texture, implementation of the presented SA method would become even more complicated and time-consuming. As sensitivity and uncertainty analysis is hardly integrated in hydrologic modelling, the available methods should be transparent, straightforward and easy to handle. The comment on the choice of the perturbation factor is very pertinent and the presented method should be further optimized with respect to the different aspects as mentioned by the reviewers. With this study we tried to supply the basis for a SA framework that allows to abandon incorrect practice of the conventional OAT-SA:
  (i) the compositional character of the input data is taken into account,
  (ii) the sensitivity index respects the time-depending character of the model output and
  (iii) there is a first attempt to optimize the perturbation factor and to recognize that the choice of this factor plays an important role in the sensitivity analysis and should not be chosen arbitrarily.
- Lines 541-542 (section 4) are added to indicate that especially near the borders of the ternary diagram deviation of the perturbation factor from its optimal value might affect the results of the sensitivity analysis.

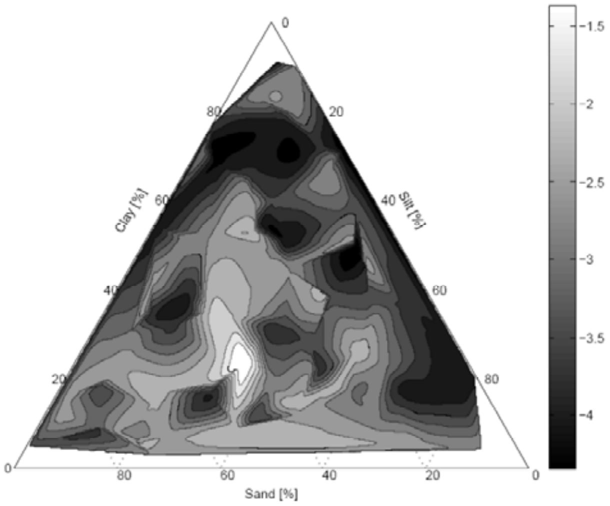


Figure 3: Optimal perturbation factor (E^x) as a function of the position in the texture triangle

2. *The second issue concerns the applicability domain of the PTF (Pedotransfer functions) used in a case study. Should the study not be limited to the soil content bands specified in lines 21-24, page 8847? Without an appropriate comment the reader might be unsure if high uncertainties observed outside these bands are not caused by methodological limitations.*
    - It is correct that strictly considered the Rawls and Brakensiek PTF should not be extrapolated outside the region and texture range for which the PTF has been developed. We chose to apply the PTFs for the entire texture triangle in order to obtain a continuous contour plot. However, it should be clearly mentioned that interpretation of the results outside the validity region should be done carefully.
    - Lines 433-435 (section 3.2.1) are added to make a note about the interpretation of the results. In the caption of Figure 6 the same remark is included.
    - On each of the texture triangles in Figure 6, the validity zone of the PTFs is indicated.

<u>Specific comments:</u>

1. *Algorithm 1 and 2 – a model realization in the point x (y (x)) is unnecessary – y (x) is unused (see eq. 7);*
    - Ok, removed from algorithm 1. In algorithm 2 a model evaluation in x is needed to be able to calculate the directional derivative for opposite directions, see Eq.(9).
2. *Section 2.3.2 – it would be sensible to clarify the reason for step 3. (page 8853,line 7);*
    - The step of determining the directional vectors is necessary to be able to perform perturbation of sample x in the direction of the selected perturbation axis. Adding the directional vectors is similar to translation of the perturbation axis in the Euclidean space.
    - Lines 273-274 (section 2.3.2.) are added to clarify this.
3. *Page: 8861, lines 11-13 – I would appreciate a comment concerning PTF applicability limits;*
    - Lines 433-435 (section 3.2.1) were added.