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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Contributions to uncertainty related to hydrostratigraphic modeling using Multiple-Point Statistics" *by* Adrian A. S. Barfod et al.

Anonymous Referee #2

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General comments

The manuscript "Contributions to uncertainty related to hydrostratigraphic modeling using Multiple-Point Statistics" presents an interesting study where the uncertainty related to the input data required by a multiple-point statistics (MPS) simulation framework is investigated. The research described in the manuscript, although focused on a specific case study in Denmark, could have a broader applicability and would probably be of interest for the HESS readers.

Nevertheless, I believe that the manuscript contains some major issues that should be addressed by the authors before its publication. In particular, my concerns are

related to three aspects: 1) The structure of the manuscript, 2) some missing details/discussion about important aspects of the parameterization of the methodology, 3) the way mathematical relationships are expressed.

Specific comments

Manuscript structure

A number of techniques are used within the manuscript to complete the quite complex simulation framework. Some of them are used multiple times and in different contexts (for example, the tau model). Therefore, putting their description in a separate section "Methods" would be much more helpful and would help the reader in orienting himself inside a quite complex work-flow. At the moment, the description of the methods is spreader all around the manuscript, sometimes together with the results, quite often with some repetition, which makes reading the manuscript not a smooth task. A clear example of this "breaking the rhythm" of the manuscript is for example at page 18. Also, here the description of the technique is made at the wrong place, because the method was already applied some step before in the work-flow. Another example is at page 21, where a 2D example is introduced to explain the EDT.

In addition, the comparison methods (EMR-maps,...) and the distances (EDT...) definitions would deserve a separate section, maybe just after or within the "methods" section.

There are also many locations, in particular in the "Results" sections, where too many details which would be more appropriate for the "Discussion" section are anticipated (see for example pages 27-28, lines 6, 10-11).

Section "Basic modeling set-up"

This section is somehow quite confusing, because the authors mix the description of the "Basic modeling set-up" with the Egedbjerg TI description. I suggest to better separate the description of the various cases.

Tau model usage
The tau model represents one of the crucial steps of the methodology, because it is used to take into account the soft constraints provided by geophysics, but also to combine the "borehole probability" with the SkyTEM one (Fig.7). Although some information about the tau weights are provided (i.e., in appendix), I would suggest to discuss at least briefly their choice. For example, many of the considerations made by the authors would be strongly influenced by the choice of the tau weights (see for example line 32, page 30). Some insights about the choice of these weights are provided by Allard et al (2012, DOI: 10.1007/s11004-012-9396-3). Also, what happens when the weights are $\pm\infty$? (see pp18, equation 2).

Case studies labelling
The provided table that summarizes all the case studies is of course useful, but overall into the manuscript (for example, in figure captions), there is very often a redundancy and some of the details of the different methods, which are repeated multiple times. Maybe you should reference much more often to Table 1 and to the "codes" like "Case 1a", "Case 1b" only, and avoid repeating the detailed differences. One example of these repetition can be observed in Figure captions (see for example Fig.9, page 25).

Introduction pp4, lines 20-
Here I would also mention the problems related to the solution of the inverse problem (IP) in itself. By the way, this also somehow motivates your efforts in trying two different inversion techniques, like SCI and sSCI.

pp5, lines 27-
Here I believe you are already providing too much details for an introduction.

Mathematical formulation
The mathematical formulation is often cumbersome, because very often long text lines are used to define quantities and as subscripts. I strongly suggest to lighten the notation avoiding long text lines, and using the many letters provided by the alphabets. For

example, N and M could be used instead of $N_{\text{realizations}}$ and N_{cells}; another example is the definition of $\mathbf{D}_{i,j}$ (page 22). In addition, some relationship could be condensed and generalized. In this way, they could be written only once and contribute to shorten the manuscript. See for example (7) and (8) at page 21.

TI non-stationarity
In section 3.1 but also in other parts of the manuscript the imprecision of MPS in reproducing some features is clearly depicted. However, I believe that many of the encountered problems are due to the non-stationarity of the used TI. Therefore, although of course taking into account for the geophysics helps, I would suggests to at least mention and briefly describe the role of the non-stationarity of the TIs.

Variograms
Could you briefly mention which variogram model you used for example to create the borehole footprint (pp18, lines 3-6)?

Figures
Fig.4: Please add a comment related to the spatial scale of the Egebjer TI, which is quite different from the other two. Also, it would be quite nice to add a sub-figure containing the same vertical proportions for the borehole logs.

Fig.11: The label "Realization number" in the vertical axis of part A is too close to part B and in therefore misleading. Also, I believe that the results of part B could be condensed using box-plots, one box-plot for each case. In this way, the fictitious and misleading order of the "realization number" would be by-passed.

Technical corrections

pp6, line 9
Please check the order in "33 line km spatially..."

pp8, line 30
It looks like the reference to Fig.4 is missing between Fig.3 and Fig.5.

pp9, line 5
"data is" => "data are"

pp18, line 18
"[2,1]" is somehow confusing with the index that you introduce some equations before... I would specify that they are float values, writing explicitly 2.0 or 1.0.

pp20, line 25
Maybe "(3)" => "(4)"?

pp21, equation (6)
Please check for the missing i subscript to v

pp21, line 20
Here Delta appears in the formula, but not in the following text... please check.

pp22, line17
"realizations using" => "realizations computed using" (?)

pp27, lines 6-11, 30-31
This is somehow repetitive. Please try to avoid repetitions also in other locations in the text, but in particular in this section.

pp30, line 26
"to alter...?"

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