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Discussions

Interactive comment on "Hydrostratigraphic modelling using multiple-point statistics and airborne transient electromagnetic methods" *by* Adrian A. S. Barfod et al.

Anonymous Referee #2

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This paper provides an exhaustive comparison of three Multiple-Point-Statistics (MPS) methodologies - namely, Single normal equation simulation (snesim), Direct Sampling Simulation (DS) and Image quilting simulation (iqsim) - for the generation of random distributions of hydrofacies on a specific field site. For each methodology, the diverse realizations of hydrostratigraphic categories are obtained on the basis of 51 stochastically-reconstructed resistivity grids, to include the effect of uncertain conditioning (soft) data. The generated hydrostratigraphic models are compared against each other and against the Training Image (TI) (i) by visual inspection, (ii) in terms of the modified Hausdorff distance and (iii) in terms of the distance from borehole (hard) data. The paper is clearly written and the results will have wide application in the con-

text of field-scale stochastic facies reconstruction. I recommend the paper for publication in HESS, after that the authors address the questions/comments in the following itemized list:

- Advantages and disadvantages of each methodology are extensively discussed, and can be summarized as follows: (i) snesim is the best one in conditioning the simulations with soft data, thanks to the implicit Resistivity Atlas histograms. This methodology provides the best results in borehole distance for 2 out of 3 hydrostratigraphic categories. However, the resulting stochastics models are affected by unrealistic small scale variability, which implies a larger distance from the TI.

(ii) iqsim is the fastest algorithm amongst the three. It provides the smallest distance from the TI and the largest variability between realizations. On the other hand, it suffers from an improper conditioning from soft-data grids, as indicated by poor borehole-distance results.

(iii) DS is the most computationally expensive, it suffers from small-scale variability (line 556) and hydrostratigraphic units are not conditioned properly (line 753). It provides intermediate results in terms of all comparison metrics considered.

So, why did the authors choose DS as the unique methodology in the "Hydrostratigraphic modelling of new surveys", in Sect. 4.3? I would recommend to integrate this section also with the results of the other two methodologies for the simulation of "Area B".

- The absence of small-scale variability in single realization (iqsim) is regarded as an advantage. But, (1) as discussed in lines 733-741, this reconstructions can be regarded as the most realistic only if the TI is actually reproducing the correct scale of variability; (2) it is the model ensemble, and not the individual random realization, that is supposed to reflect the behavior of the whole system. Small-scale variations effect seem indeed to be reduced when evaluating the mode over the 10 realizations in sect. 4.3. The ensamble modes evaluated over each one of the three sets of 51 simulations

analyzed in the first part of the study should be also reported.

- It is not explored in this context how the three algorithms behave when generating random simulations with fixed conditioning data. What are the effects of the methods themselves on, e.g., the variability between realizations?

- line 458: " Here, sand & gravel and glacial clay were categorized into a single category, and hemipelagic clay was used as a background variable". The Modified Hausdorff distance is evaluated on binary images. Did the authors try to evaluate a MHD array separately for each category (similarly to what it is done for AEBD)?

- line 726: "The borehole distances of the iqsim realizations revealed exceedingly small hemipelagic clay distances, with average of 0.2 m"; line 730: "(...) the ample near surface hemipelagic clay decreses the hemipelagic clay borehole distance". If the presence of near-surface hemipelagic clay is an artifact of the algorithm (i.e. is not consistent with borehole data), why should it results in a decrease of the borehole distance?

- Figure 2: the figure caption and the references to the figure in the manuscript are not consistent with the letters (a-g) indicating the diverse frames of the picture.

- Eq. 2: Symbols a_i and b_i represent position vectors, but they are written as scalar quantities.

- line 536: "where binlog_i is the ith cell in the binary log grid" should be changed into "where binlog_i is the ith ACTIVE cell in the binary log grid".

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