

Review of the manuscript hess-2020-96
“3D Multiple-point Statistics Simulations of the Roussillon
Continental Pliocene Aquifer using DeeSse”
by Dall’Alba V, Renard Ph, Straubhaar J, Issautier B, Duvail C,
Caballero Y

25 May 2020

1 General comments

This manuscript provides an improvement of the MPS implementation through the direct sampling algorithm, in order to design a method for the reconstruction of aquifer heterogeneity at scale lengths of tens of kilometers.

Overall, the work is interesting and deserves publication. The paper is generally well organized and written, but it can be improved following the suggestions given in the specific comments # 1 and 6. Some other weak scientific flaws can be fixed with a moderate to major revision.

2 Specific comments

1. The abstract is a long summary of the work, but it does not give a precise and clear image of the innovative content of the work. I think that it should be shortened and focused in a more appropriate way. Moreover, a similar comment applies to the introduction, which describes general properties of MPS, but does not properly introduce the specific methodological question which is faced with this work. The description given at lines 70 to 75 is not very exciting and informative. In my opinion, most of the material in section “3.1 Overview” should be anticipated in the introduction, in order to give a better presentation of the innovative character of this work at the very beginning of the paper.
2. For a long part of the manuscript, it was not clear to me whether the TIs were horizontal maps or vertical cross-sections. Moreover, the way in which 2D horizontal maps are used along the vertical direction should be better analysed. For instance, it would be useful to draw some vertical cross-sections in order to show the effects of the two simulation sets (with and without vertical sampling). In fact the analysis shown in figure 10 is not clear enough.
3. Section “3.2 Hard data set” could be improved.
 - (a) There is some confusion between electrofacies and sedimentary facies.
 - (b) And what about hydrofacies, which are ultimately the most important for hydraulic conductivity?
 - (c) What about lithological logs? Usually they are available if a borehole is drilled for geophysical logs.
 - (d) Details about the data set, e.g., position and borehole depth, are missing.
4. Section “3.3 Training images” is not very convincing. It shows that different TIs give different results and some of these are not appropriate with the geological structure of the study area. This is well known and was clearly proved by some of the authors in previous papers. It is well known that the TI should mimic the structures which are expected in the study area and this should be known *a priori* from geological studies. Moreover, further details should be given for figure 2a, which shows a strange sedimentary structure (see specific comment # 14). I am afraid that the term “braided river facies” is probably used in a non rigorous way. In fact, figure 2b shows the typical structure of a “braided river”, with a great number of intersecting channels. In other words, areas characterised by meandering rivers show a very strong heterogeneity at relatively fine scale. This is not properly represented by the TIs.
5. Figure 8 shows that high probability for “floodplain” facies determines approximately linear structures. It seems that these structures separate the similar geometrical features observed for “braided river” and “meandering

river” facies. Is this right? This seems to be implicitly stated also in the text. In individual simulations, “floodplain” facies should be more widely distributed, shouldn’t it? Why these maps show a different structure? Is this due to the constraint given by the elongated features for highest probability of “river” facies?

6. The orientation is missing in all the figures and the scale length is missing in almost all the figures.

3 Technical comments

1. Line 28. The acronym “PC” is used for the Continental Pliocene aquifer. Moreover, in a couple of sentences, I was confused and I read PC as “personal computer”. I understand that “PC” is probably the correct acronym based on initials of French words, but I think that “CP” would be more appropriate as an acronym for the English name.
2. Line 40. Correct “1974)”.
3. Line 58. Correct “Hu, 2008)”.
4. Line 68. Substitute “,” with “.”.
5. Lines 95 to 97. I recommend the authors to carefully follow the international recommendations on the use of SI units and style conventions, in particular the guideline # 12 at the following URL:
<https://physics.nist.gov/cuu/Units/checklist.html>.
This applies also to other parts of the manuscript.
6. Lines 95, 97, 110. Substitute “extend” with “extent” or “extension”.
7. Lines 99, 199, 213, 215, 217, 223-225, 286, 344, 345, 361, 362, 404, 419. I think the use of “meander” as adjective is not correct. I suggest to substitute “meander river” with “meandering river”.
8. Line 104. Substitute “plain itself” with “floodplain”.
9. Line 112. Substitute “in” with “at” before “some locations”. Rephrase “up to 8m higher on average”.
10. Line 117. Substitute “of” with “by”.
11. Line 166. It is not clear if the TI is a map in the horizontal plane or a vertical cross section.
12. Line 171. Which is the direction of the x coordinate axis?
13. Lines 196-197. Clarify the expression “By studying the evolution of these response curves”.
14. Line 212. The expression “an analogue river system from northern Italy” does not provide a useful information. Which river? Which kind of geological setting? Moreover, from figure 2a, the braided river facies cover an extended area and does not properly represent the internal heterogeneity of a braided river system.
15. Line 216. Substitute “meander objects” with “meanders”.
16. Lines 285-286. Why “the best way to control the vertical continuity was to sample only from three facies”? Can you comment on this and explain this result?
17. Line 319. Substitute “doesn’t” with “does not”.
18. Line 340. Substitute “are” with “is”.
19. Line 385. Add “a” before “complex”.
20. Lines 401 to 403. This remark is not so evident from the analysis of the results.
21. Line 495. Erase “Tectonophysics”.
22. Figure 3. Substitute “c)” with “b)”.