Review: "3D Multiple-Point Statistics Simulations of the Rousiilon Continental Pliocene Aquifer using DeeSse"

General comments:

This manuscript presents a method for large-scale 3D MPS simulations in areas without the necessity of creating a 3D Training Image, which can be a cumbersome and tedious task. Especially, the presented method focuses on areas with few geological observations and little to no geophysical data (soft conditioning data). Overall, a well written paper, albeit with some technical errors, which can easily be corrected. I recommend the paper for publication. Moderate review.

Specific comments:

1. Line 21-22: Explain why we want to skip this step. There are researchers who spend a large portion of their time building handheld 3D geological models and would not understand why it is an advantage to bypass the 3D TI.
2. Line 51-61: A good overview, perhaps also mention Image Quilting Simulation (IQSIM) (Hoffimann 2017 - Stochastic simulation by image quilting of process-based geological models) and other more recent methods if any.
3. Line 68-69: Slightly elaborate "many options", so that the reader can grasp the advantages/disadvantages of DeeSse better.
4. Line 124-125: I think you mean two-point statistics. A variogram is not a geostatistical method, but a mathematical/statistical construct that is used in different geostatistical methods.
5. Line 180-181: Making 3D Tis is not "*too complex*". In fact, in the literature, many studies are presented where handheld 3D geological models are created, which are essentially 3D TIs. Rephrase it to emphasize that it is a difficult, time consuming and subjective way of modeling, but NOT "*too complex*".
6. Line 201: What geological map? You should show it or cite it. If it is the one in Figure 1, then include a reference to figure 1 here.
7. Line 204-205: If it is essential to condition the model to the geological map, then you should describe how you do this.
8. Figure 3 caption: What is c) referring to? And b) is not mentioned. Needs to be fixed. Also, the grey model makes sense, but you should still describe it in the figure caption.
9. Figure 4: In the b) and c) it would be a lot better if you added a thin black line to mark the outline of the layers, especially in relation to the stacked trend map in c). As for the current state of the figure I do not really get a lot of information from the stacked trend maps since all the colors of the different layers are identical by design.
10. Line256-257: What do the diffusivity equations look like? And what is considered "*proper boundary conditions*"?
11. Line 274: Insert a reference to Figure 5b) here
12. Line 276-277: Since river system are highly dynamic in nature, and since the reader has no idea about the sedimentation rates over the last 6 My in the given sedimentary basin, you should probably state why we can safely assume that the variation of the paleo orientations are encompassed by +/- 10 degrees of the values observed at the surface currently.

13. Line 285-287: Seems a bit discerning, can you elaborate as to why the vertical continuity was not as good when all 6 facies were included for sampling?
14. Figure 7: You should always introduce each sub figure in order a) -> b) -> c), not a) -> c) -> b). Also, a very important detail is that nowhere in the paper do you present a vertical slice, or profile, of the simulated models, so the reader cannot see how bad/well the vertical constraints worked in comparison to a full 3D TI. It would be easy to add a cross section view in this figure.
15. Line 346-348: How do the maps explain that the model is not over constrained? It might be obvious to you, but not necessarily the reader.
16. Lines 385-387: I think you are going need to touch on the strengths/weaknesses when making a comparison like that. The so-called *classical MPS studies* simply have a lot of geophysical/conditioning data available to them, and will, in large, be better conditioned to the actual subsurface. On the other hand, your method is clearly advantageous when you do not have a lot of geophysical/conditioning data available, but of course will not be as nicely conditioned to the actual subsurface. There are many places in the world where they need methods like this, since they do not have elaborate geophysical data sets available to them.
17. Line 408-409: How are they satisfactorily reproduced? Based on what? Is it solely based on the boreholes being conditioned correctly and the simulations resembling the TI? Then, it would be nice to show some statistics regarding how well the boreholes and simulations agree.

Technical comments:

1. In general, it is not called a “meander river”, but a “meandering river”. This needs to be fixed.
2. Line 28: The abbreviations for Marine Pliocene aquifer is PMS. Perhaps this is an abbreviation that makes sense in relation to the French name for the unit, but in order to make the paper more readable I recommend using MPA, which makes more sense.
3. Line 28: Similarly, the abbreviation for Continental Pliocene is PC. It would be more fitting to use CP.
4. Line 68: Change “It” to “it”, *i.e.* no capital letters after comma.
5. Line 76-77: Add “:” after “The paper is structured as follows”, followed by changing “The” to “the”
6. Line 78: Missing comma after DeeSse algorithm, and “Section 3” should not have a capital letter
7. Line 95: You mean the “extent” and not “extend”.
8. Line 238: change “express” to “expressed”
9. Line 360: Change ”the allivial fan dominate” to “the allivial fan dominates”