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Hydrology and Earth System Sciences Discussions

Interactive comment on "Analyzing the effects of geological and parameter uncertainty on prediction of groundwater head and travel time" *by* X. He et al.

Anonymous Referee #2

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1 General comments

The paper *Analyzing the effects of geological and parameter uncertainty on prediction of groundwater head and travel time* presents the results of comprehensive and interesting research about uncertainty. The uncertainty on the geology and on the hydraulic parameters are investigated with geostatistical methods (multiple-point statistics, transition probability) and parameters estimations (PEST).

The manuscript is clear and well written, and in general the results are presented

correctly.

However, the approach used for the implementation of the multiple-point statistics (MPS) method is debatable. The authors build their training image (TI) using the results of a geophysical survey. As they observe in the conclusion "usually geophysical data have been used as soft data conditioning", and I think this should be also the case. The results of the geophysical survey is specific to the site considered in this study, therefore it should be used to constrain (*"soft data conditioning"*) the results of the MPS simulations, rather that to create a TI. The approach adopted by the authors would have been coherent if the geophysical survey was carried out on another *analogue* location, even close geographically to the study area. In the case considered in this study, the results of the geophysical survey can provide valuable *soft conditioning* information that can help **reduce** the uncertainty. This would *"embed"* more *"field evidence"* into the geological model. Therefore, why not use these data as soft conditioning and create instead a simpler TI using for example object-based methods?

2 Specific comments

2.1 Create the TI with object-based methods

The results of the probability transition study and of the geophysical survey could provide hints for the construction of a TI using object-based methods.

Moreover, using the geophysical data as soft conditioning could be useful to address potential *non stationarities* which might be present instead on the TI extracted for the geophysical survey.

2.2 The TI is a “privileged” realization

In this case, it would be interesting to see what happens to the flow simulations when the geological heterogeneity is represented by your TI.

2.3 Significant figures

When reporting numbers, I think that it is important to report correctly the significant figures. For example (see table 2), does it have sense to report a value for the hydraulic conductivity of 4.55 when its standard deviation is 68? Or a 16 years daily average discharge of 69 265 $m^3 d^{-1}$.

2.4 SNESIM description

I suggest to improve the description of the formula (1) (page 2797) as it is not clear.

Moreover, it is not clear why the *mean length* of each sedimentary unit (pp2802, par20) is required by SNESIM. Maybe to define the radius of the search template? Please explain.

2.5 Scenarios description

The description of the various scenarios (i.e., in section 3.3) would be clearer if made in a more schematic and homogeneous way.

Also, it seems that the terms *ParModel* and *GeoParModels* are confused and used to denote the same scenario (3rd?). In the tables, another denomination (*GeoPar*) appears.

Moreover, the title of section 5.2 seems to be devoted to the scenario I only, but it contains a general introduction to all the scenarios. It is confusing because you report that *“each model was calibrated by PEST”* (pp2804, par25) and then *“the models were not calibrated”* (pp28015, par10).

2.6 Inference of the sand bodies dimensions

In the text, it is not clearly explained how the values of the dimensions of the sand bodies where estimated. For example, from the top-left figure of Fig.3, it is not easy to infer these quantities from the slope of the curves.

3 Technical corrections

pp2796, par10 See comment about the significant figures.

pp2803, par5 *“mean length of Quaternary sand”*... please add something like *sand bodies* or *sand sheets*.

pp2808, par25 GeoParModel-I

Table 2 The meaning of standard deviation of a quantity that has a log-normal distribution is not straightforward.

Table 3 Check *ParModel*, *GeoPar*, *ParModel*.

Table 4 see comment for Table 3

Fig.4 In the figure you use the letters A,B, but in the caption X-Z. Please use an homogeneous notation.

Fig.6 (This is just a detail) Maybe using the same color scale for the images of the left and on the right would make the comparison easier and the results even more evident.

Fig.7 Please specify the scenario considered.

Fig.8 Here the fonts are a little small. Also, probably using the same intervals and the same parameters in the creation of the histograms would make the comparison easier.

Fig.10 This figure is interesting, but somehow too charged. I suggest to split into 3 subplots: Observations/GeoModel-I, Observations/GeoModel-II, Observations/GeoOPar.

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