Author response on “egusphere-2022-81”

# 3D hydrogeological parametrization using sparse piezometric data

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Dear Referee, the additions are highlight in yellow in the track-changes version of the manuscript uploaded in Egusphere. We list below the changes corresponding to each of yours remarks.

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RC#1

Dear authors,

1) The proposed method is only digestive for those who have specialized knowledge of the entire tools presented.

> Both more general introduction and more precise elements on the tools were added.
>
> For TRACES and direct calculations: lines 106-107; 140-141; 144-146
>
> For PINOGRI and inversion: lines 170-173; 197-201; 215-216
>
> For facies interpolation (GemPy and B-splines): lines 228-230; 236-240; 259-262
>
> For the optimization of the hydrofacies parameters: lines 274-286

2) Please mention the innovation compared to similar works.

> As stated in our previous response, we integrated comparison with Viaroli et al. (2019) (lines 36-38) and Harp et al. (2008) (lines 45-47).

3) Most important the presented methodology is very complex to be reproduced. I am not saying that is bad! but there also similar works in the literature that do the same work with a simpler manner. Maybe it would be good, if possible, to have a comparison with one of them. Your method is more detailed but compared to simpler approach the performance is far more efficient? Otherwise, what is the reason to have such many methodological and sometime complex steps.

> Along with the response given in a previous round of reviewing, we didn’t add elements regarding this point. Indeed, our method is not so complex considering what it offers: estimating both 3D flow parameters and aquifer structures, based solely on piezometric series and vertical logs descriptions. Most studies on 3D aquifer modeling use multi-methods/joint inversions based on costly geophysical field data. We do not have experience of those studies that propose 3D modeling in an even simpler way.

4) paragraph 2.4 The optimization part needs more details. It is not clear how optimization works here.

More details, including an equation formulation of the optimization problem, have been added on lines 274-286.

5)The proposed 3d methodology consist of inversion, interpolation, optimization. All these steps consider parameters. Therefore, an uncertainty analysis is required to study the uncertainty propagation.

6) How realistic is the upscale of such model to a real case study. I understand the research orientation which is very strong but, this is also a matter of discussion.

7) The fixed parameters of the aquifer model regarding transport it would be good to be accompanied by a sensitivity analysis.

These last 3 points were addressed in the conclusion (lines 403-407).

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RC#2

The authors should support their approach, i.e., the transmissivities versus the hydraulic heads conditioning, comparing the two inversion strategies and showing the advantage to compare the 2D transmissivities rather than the vertically averaged hydraulic heads.

The advantage of our method relying on a 2D transmissivity constraint, both in terms of data acquisition and computational efforts, compared to 3D joint inversions, is highlighted in the introduction (lines 37-43). The references provided by the referee (Straface et al. 2011; Guadagnini et al. 2004) have been added (lines 33-35) to complete the state-of-the art and to introduce the novelty of our own approach.