Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2017-447-RC2, 2017
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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Groundwater withdrawal in randomly heterogeneous coastal aquifers" *by* Martina Siena and Monica Riva

Anonymous Referee #2

Received and published: 21 August 2017

GENERAL COMMENTS

Seawater intrusion is a major problem in coastal aquifers, and several studies are attempting to improve its numerical simulation. The authors want to underline how 1) the heterogeneity of the porous media impacts the numerical simulations of coastal aquifers and 2) different configurations of the pumping scheme effect the position of the saltwater wedge and the width of the mixing zone. To answer these questions, the numerical solutions of the coupled flow and transport equations are compared considering homogenous and randomly heterogeneous permeability of the porous media. I find the topic of the manuscript of interest for HESS readers. The methodology presented is clear and the manuscript is well written.

However, in my opinion further investigation is needed to better support the conclusions

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Discussion paper

proposed. In particular I am concerned with the following points:

1) The Monte Carlo analysis is performed using only 60 random realizations. I can understand that MC simulations of this 3D, coupled system are computational intensive, however a brief analysis on the convergence of the MC scheme is required to understand the sensitivity of the first and second moments of the computed metrics to the ensemble size (e.g. in the case without pumping).

2) Most of the conclusions are not fully supported by the results, as only one aquifer and one heterogeneous configuration have been considered (e.g., the first point: 'heterogeneous aquifer systems are characterized by tow penetration and extent of the mixing zone that are respectively smaller and larger than their counterparts . . .' . An analysis of the variability of the considered metrics with respect different configurations of the permeability random field (e.g. large/small variance and large/small correlation length) would better support the proposed general conclusions. Otherwise, the conclusions should be revised referring only to the case studied.

3) By considering only three pumping schemes, I find hard to conclude that the position proposed in S3 is the best. How did the authors select the position of the well in S3? Is it possible to select the position in such a way to minimise the considered metrics (e.g. for one configuration of the random permeability)?

SPECIFIC COMMENTS

Page 6, line 19: I was not able to find the reference Almagro Landò et al. (2010). Please, report in the manuscript the details about the recharge and the head in the inland. It should be stated that these boundary conditions as well as the assumption of a fully saturated domain play a fundamental role in the determination of the SWI.

Section 2.3: which are the initial conditions for the flow and concentration equations?

Section 3.1: during the 8 years of the simulation, has the recharge any impact on the SWI? Is the solution after 8 years independent from the choice of the initial conditions?

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Page 8, lines 18-29: these metrics should be presented in the ‘Materials and Methods’ section. A table summarizing the meaning of the seven metrics could be of great help to better follow the results.

Section 3.2: the description of the four pumping schemes (S0-S3) should be presented in the ‘Materials and Methods’ section.

Page 13, line 11: replace ‘associated a’ with ‘associated with a’.

Figure 1: Could you provide a small map of Spain indicating where is the Argentona aquifer? It would also help to delineate the boundary of the model grid in panel (a).

Figure 2: please indicate the depth of the left and right boundaries in panels (b) and (c).

Figure 4: the variability of the considered metrics with respect to the single random realisations is not of interest, as it is already expressed in the confidence interval associated to the ensemble mean. It would be more interesting to see their sensitivity to different parameters describing the spatial correlation of the permeability (e.g., short vs long correlation length, high vs low variance).

Figure 10: the vertical bars representing the 95 % confidence interval should be much wider. Why the authors divided the standard deviation by the square root of n (page 12, line 12)? This operation should already be done in the computation of the standard deviation. Please, check the result and correct the figure.

References: Almagro Landò et al. (2010): is this document public? This document is cited several times along the manuscript, but it seems to be not available online. Could the author upload this report?

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