Hydrology and Earth System Sciences Discussions

Interactive comment on "Quantifying flow and remediation zone uncertainties for partially opened wells in heterogeneous aquifers" *by* C.-F. Ni et al.

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Received and published: 5 May 2011

We appreciate the comments from anonymous referee #1 for our paper. The comments would help us to improve our model and also the way we present our study. The following is the summary of our responses to the comments from referee #1.

Responses to the general remarks: It is true that the real word heterogeneity in an aquifer is three-dimensional and is very complex. Depending on the issues to be discussed, a simplification of such complex system is often the standard procedure for most investigations to narrow down research topics. In this study we have made our

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model to a two-dimensional one to present the first-order spectral method and the associated particle-based approach for quantifying remediation zone uncertainties. Important issues such as the degrees of small-scale K heterogeneity, the anisotropy of small-scale K heterogeneity, and the effect of composite media (illustrated with layered aquifer in this study) are discussed to obtain insight into the operations of a single well remediation system in a heterogeneous aquifer system. Although the proposed model is limited to two-dimensional problems, the results and the conclusions presented here should be consistent with the system responses. For a fully three-dimensional problem, the quantities shown here may not be exactly fit the three-dimensional problem. We will expect similar patterns to be obtained in three-dimensional problems.

Figure 3 shows the mean head distribution for our test example. As shown in Equation (4), there is a nonlinear term (Jr/r) for our model to show the result of mean head along r-direction. I'm not really sure if I fully understand the point raised by referee #1. In the attached figure, we plot the head profiles along the center line (along r-direction and fix z =10) with and without the Jr/r term. The figure clearly shows that the differences of mean head values along r-direction, especially near the well location. One possible factor to show relatively flat flow pattern may be the constant head boundary condition applied at well screen location in this study. Constant head and constant flux boundary conditions for well locations were previous discussed in detailed by Indelman and Dagan (2004).

Responses to the specific remarks:

Page 3135, Line 17: "Kunstmann and Kinzebach, 2000". Correct: Kunstmann and Kinzelbach, 2000. Page 3136, Line 3: Same

Response: This will be fixed in our MS. We are sorry about the misspelling of the last name Kinzelbach for the cited references.

Page 3138: Obviously no horizontal/vertical anisotropy is considered. This is in contradiction to field observations.

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Response: Equations (4) to (6) show the mean flow equations for our model. The geometric mean of hydraulic conductivity here can vary with different locations in the developed model. In our model a large-scale trend with horizontal/vertical anisotropy can be flexibly applied to other simulations. One of our objectives is to assess the effect of geometric mean K values on the on the remediation zone uncertainties (illustrated with a two layer aquifer). The geometric mean K values will lead to significant variations of remediation zone patterns. If the large-scale anisotropy conditions are the main concern for most practical applications, we can add more cases to focus on this issue. Thanks for the comment.

Page 3139. The selected covariance model is missing. Response: Thanks for the comment. We will insert the covariance model in the text.

Figure 1: The text within Figure 1 is not complete. Response: The missing words are "tracking time." We will revise the figure. Thanks.

Reference: Indelman, P. and Dagan, G.: A note on well boundary condition for flow through heterogeneous formations, Water Resour. Res., 40, W03601, doi:10.1029/2003WR002602, 2004.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 3133, 2011.

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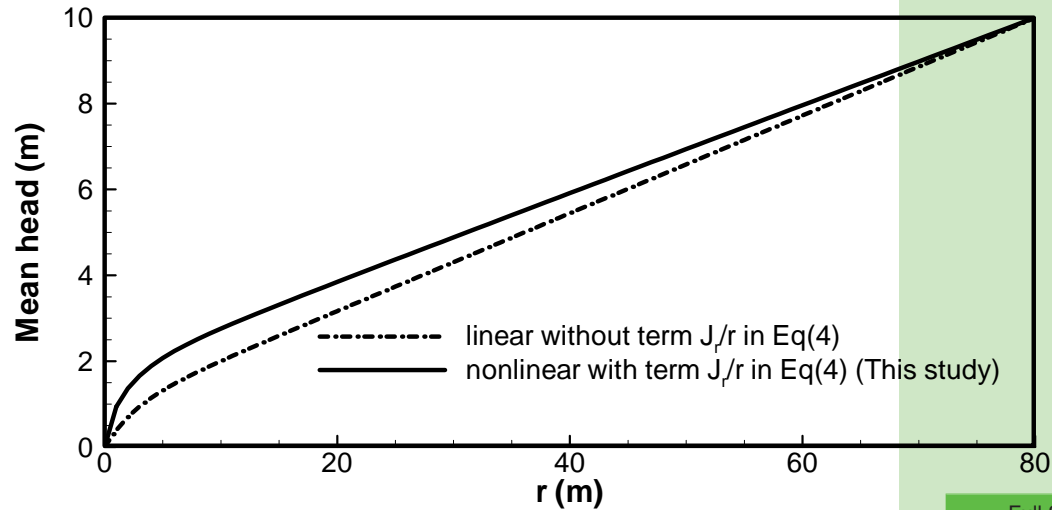Printer-friendly Version

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Figure: The mean head distribution for fixed z (z=10m) and along r-direction for cases with and without nonlinear terms in equation (4).