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Discussions

Interactive comment on "Is inversion based high resolution characterization of spatially heterogeneous river bed hydraulic conductivity needed and possible?" *by* W. Kurtz et al.

Anonymous Referee #3

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Manuscript: Is inversion based high-resolution characterization of spatially heterogeneous river bed hydraulic conductivity needed and possible? Authors: W. Kurtz, H.-J. Hendricks Franssen, P. Brunner, and H. Vereecken Manuscript Number: hessd-10-5831-2013

This paper proposes the use of the ensemble Kalman Filter (EnKF) to invert the river-bed conductance, L, by adopting models with different levels of resolution, from a fully heterogeneous one to others characterized by "coarser" upscaled zonations. The methodology relies upon the use of a finite-element (FE) variably saturated flow model, which is used to simulate the stream-aquifer interaction. Collected data include water

table levels, H, at a number of observation wells. The numerical tests show that the inversion of the conductance at higher resolution is feasible and provides a better characterization than when using three proposed zonation schemes.

The paper is of interest to the readers of HESS and touches on some important aspects of the applicability and the flexibility of the EnKF as model inversion tool. The paper is well-written and organized. However, it needs some general improvements in terms of providing a more detailed description of the model setting, which ideally would make it possible to reproduce the results of this work.

From a scientific standpoint, I would like the Authors to address the following concerns in a revised version of their manuscript. These concerns are listed in order of importance.

1) In my understanding, in all scenarios the only source of uncertainty taken into consideration is the spatial distribution of the river-bed conductance. All other hydrogeological parameters, for example, the hydraulic conductivity (K) field and the coefficients of the soil moisture and relative hydraulic conductivity laws, are known deterministically. I find this assumption rather unrealistic, so much so it may be very difficult to translate the results of this work to more realistic scenarios. My major concern is that in a (very likely) situation where, for example, also the K field in the aquifer was unknown, it would be hard to narrow down the L distribution using head measurements alone, as the K-L correlation would be masked by the much stronger K-H correlation. In that case, the answer to the question in the title would be closer to a NO than to a YES. It would be very useful if the Authors cast some light on this potential problem in the discussion.

2) The results show that the assimilation of 10 measurements produces results comparable to those obtained with the assimilation of 100 measurements. In my opinion this finding is not general but very specific of the adopted model setting, given that the hypothesized correlation scale is quite large (1000-2000 m) with respect to the scale of the system domain (around 7000 m length based on Figure 1). A large correlation scale

spreads the effect of measurements to a large distance and thus smaller datasets are necessary. Vice versa, if the correlation scale is smaller, the number of measurements must be inevitably much larger since their effect is limited to small scales.

3) I found it hard to understand the model setting with a sufficient level of confidence. For example, it seems that the river-bed conductance was in substance generated with a one-dimensional simulator a then projected somehow to the elements of the FE mesh discretizing the trace of the stream. It is unclear if any hypothesis on the transversal L heterogeneity was made. My understanding is that the Authors might have used a single conductance value for each cross-section. However, a close look at Figures 3 and 4 seems also to indicate that multiple values are used for each cross-section. Please clarify these points.

4) It would be useful to the Reader to know more about the computational requirements of running a 3D variably saturated flow model that needs fine characterizations of the unsaturated zones. The computational cost must be significant, given that the test cases presented here appear to have required about 400 simulations (100 for the heterogeneous case and 100 for each of the three zonation schemes) for each of the scenarios A,B, and C, for a total of 1200 model runs.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 5831, 2013.