

Interactive comment on “Nonlinear effects of locally heterogeneous hydraulic conductivity fields on regional stream–aquifer exchanges” by J. Zhu et al.

Anonymous Referee #1

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This paper uses numerical experiment method to investigate the effect of local heterogeneity on regional exchanges of water between stream and aquifer based on a case study in the middle Heihe river basin of northwestern China. Three hypotheses are tested using numerical simulation: (1) small scale heterogeneity should be taken into account, (2) if not, the stream-aquifer exchanges estimates will be biased, and (3) the biases are attributed to the slow path in groundwater flow due to local heterogeneity. Hypothesis 3 is the main target of this paper and it is tested by comparing the model results with zonal effective parameters against those with local heterogeneity. This paper is well written, and the framework to test the hypotheses is well designed and logical.

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The research topic is of interest to the readers of HESS journal. It is recommended to publish if the author can properly address the concerns as presented below.

My main concern is that this paper generates a spatially uncorrelated random conductivity field to investigate the effect the local scale heterogeneity, and the conclusion of slow path emergence is based on the assumption of uncorrelated conductivity field. It is known and also shown in this paper that the groundwater flow is more sensitive to the low conductivity values. The groundwater flow may encounter low conductivity values more uniformly (in a statistical sense) and the slow path may emerge consequently. However, in reality, it is well known that the conductivity field is spatially correlated, and in some cases, the preferential flow path will emerge due to this spatial correlation. Even though the author considers generating correlated field as the future work, it is necessary to explain more why to make “uncorrelated” assumption here.

Minor concerns: 1. Does “second” in Line 26 of Page 5 follow “First” in Line 18 of Page 5? If so, should they be in the same paragraph? 2. Line 14 on page 12: Is this conclusion based on Figure 2c? If so, please add the reference. 3. It is better to add a dashed zero-line on Figure 2c so that the differences of groundwater table below (or above) 0 can be explicitly shown. 4. Figure 3b is a little hard to read. It is suggested to use gray color for water table depth and improve the contrast with monthly leakage data. 5. Line 1 on page 15: Is this confidence interval computed based on 10 realizations generated using equation (1) and (2)? Is the realization number sufficient to make a reasonable statistics?

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