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Interactive Comment

Interactive comment on "Reducing the ambiguity of karst aquifer models by pattern matching of flow and transport on catchment scale" *by* S. Oehlmann et al.

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Dear referee,

We thank you for your critical and helpful comments. In the following we will answer your specific questions.

Comments

1) Many of the general conclusions about the properties of the aquifer overreach what can realistically be determined by such a small set of simulations. As an example, the authors conclude that the volume of the conduits must be within a certain range. How-

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ever, the parameter space for conduit properties is very large, because their position, size, and connectivity must be determined. The simulation sets presented only sample this space very sparsely. Therefore, it is not clear to me that such general conclusions can be made. Similarly, conclusions about karst model calibration, such as the statement that "this study demonstrates that for a steady-state flow field the hydraulic conductivities of the fissured matrix can practically be calibrated independently of the conduit parameters," also seem suspect given how little of the parameter space has been explored.

Answer: We agree that the location and interconnectivity of the conduit system are important parameters for any karst conduit network that, however, cannot be accessed from direct measurements. Before we started with the numerical modelling we performed a hydrogeological system analysis in order to assess certain parameters independently from calibration with the aim of reducing the set of simulations. We combined results from different studies (aquifer geometry, positions of karst conduits, catchment area size, average recharge, parameter ranges for the fissured matrix hydraulic conductivity, maximum conduit volume) in a systematical way with the shown physically based modelling approach. Therefore we believe, that the results show the most probable parameter sets and their variation. The further advantage of our physical modelling approach is the possibility to integrate additional data from future investigations. We agree that the approach requires a well investigated test site, as in our case, the Gallusquelle spring with identifiable parameters and boundary conditions. This allows us to reduce the parameter space to be analyzed during calibration.

As mentioned in our reply for Referee #3, we added in our discussion that the hydraulic conductivity of the matrix can be calibrated based on spring discharge and hydraulic heads as long as the conduit conductivity does not act as a limiting factor. Figure 1 in this response shows the influence of the hydraulic conductivity of the fissured matrix. Figure A shows the influence on the fit of the hydraulic head distribution. Figures B and C show that there is practically no effect in conduit flow velocities.

HESSD
11, C4734–C4738, 2014

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2) In a number of places in the manuscript physical explanations are confusing or in error. For example, on page 9289 they state that the transport equation is multiplied conduit cross-section, but multiplying the equation by a constant factor would have no effect. What is meant here? The authors also describe on page 9295 that, “While the ïnËĞC′ ow cross-section gradually grows with time, the surface-volume ratio increases as well leading to a higher roughness, further enhanced by exchange processes between the individual conduits.” Surface-volume ratio should decrease with increasing crosssection. It is completely unclear to me why higher roughness would be expected for larger cross-sections. The reasoning here is at least confusing and possibly incorrect. On page 9298 the discussion of dissolution under turbulent flow is incorrect. The diffusion boundary layer is not only present under turbulent conditions, but is also actually what would produce differences in dissolution rate due to differences in flow velocity.

Answer: We improved all the passages you mentioned in the manuscript. As for your questions:

1. The conduit cross-section is not constant, because the conduit radius depends on the conduit length as defined in Eq. 1 (p. 9285). However, only the left-hand site of Eq. 8 is multiplied by the cross-section, the source term is excluded. We will correct the sentence.

2. As we tried to explain in the paragraph, the increased cross-section of the simulated single conduit is not due to the widening of a single conduit in nature but due to an increased cross-section of a bundle of conduits, represented by a single conduit in the model. Therefore, the surface-volume ratio does not decrease with increasing cross-section as it would for a single conduit. For a more detailed explanation, please see our answer 5 for Referee #2.

3. You are right, that the sentence about the diffusion boundary layer is incorrect. We will of course correct it, but it will not have any influence on our conclusions.

3) The introduction and discussion are lacking in their discussion of relevant literature and how this work relates to the work of others. For example, similar work on identifying conduit properties from flow and transport has been conducted by Saller et al. 2013, Hartmann et al. 2013, and Luhmann et al. 2012, just to name a few. A more thorough literature search and discussion is required.

Answer: We extended the literature references and discussion accordingly.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 9281, 2014.

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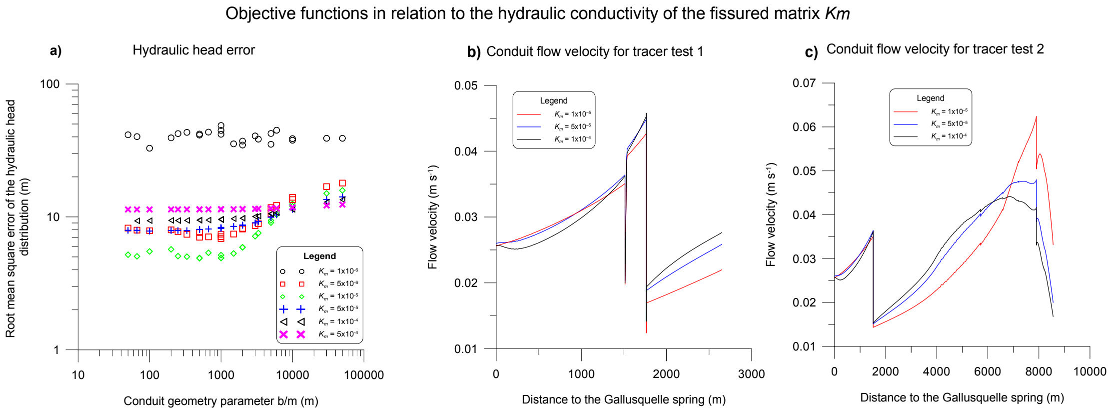

Fig. 1. Influence of the fissured matrix conductivity a) on the hydraulic head distribution in relation to the conduit geometry, b) and c) on the tracer velocities.

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