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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Influence of input and parameter uncertainty on the prediction of catchment-scale groundwater travel time distributions" *by* Miao Jing et al.

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Summary:

The proposed study explores controls on residence and travel time distributions in a forward coupled model exercise, using a coupled version of the mHm and OpenGeoSys models. Study area is the Naegelstaedt catchment in Germany. The authors explore 8 different recharge scenarios from the mHm which serve as input to the ground water model and which are marked by tracer to tag the path and the age recharge water when it travels through the aquifer to the stream. To this end tey generate several realizations of random hydraulic conductivity fields which are constrained to fit a set of

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distributed head data. The authors compare their simulated travel time distributions to an exponential travel time distribution which is based on an analytical solution, which reveals stronger skewness in the simulated ones. The author do furthermore quantify the uncertainty in average travel time, shed light on the fraction of active to total storage and discuss the age selection of the catchment.

Evaluation: The proposed study has a high scientific significance and I very much like the general approach. Nevertheless, it is in the present form not acceptable, because quite a few important points need further clarification and the presentation quality is up to the standard of HESS.

Major points:

- Eq. 9 (the master equation) assumes that storage components of an age tau <T are well mixed. I wonder whether this can be assumed for the selected random fields. This depends strongly on the correlation lengths and the total extent of the domain and maybe even more on the question whether preferential flow paths are present here? Are they present? And what is the correlation length of the generated random fields, and the nugget to sill ratios? How did you assess this information and did you vary them between the realizations? Or this this uncorrelated noise?

- There might be a conceptual problem, depending on what your particles shall actually represent. In case the particles shall mark the travel path of water (not of a solute) I think they should move in a purely advective manner, which means that eq. 6-8 need to be different. There is not diffusive mixing among water molecules (as long as we neglect different isotopic compositions). Or do they mark the fraction of different water isotopes, than this should be stated? But in this case I wonder where the dispersivity does stem from? Other tracers?

- The recharge amount, the generated parameter fields and base-flow production are not independent. I see that the ks parameter field is adjusted such that the generated parameter sets match the head data (which is by the way not so difficult). But to have

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a consistent model the simulated base-flow production from OpenGeoSys needs to match the simulated base-flow of the mHm (which is calibrated to stream flow). A consistent match of both the head and the base-flow is crucial for credibility of the model structure and it's ability to simulate travel time distributions for the selected system.

Technical details - The control for contamination is in fact the Dammkoehler number, which relates residence times and degradation time scales.

- Eq. 9: PQ (T,t) is a exceedance probability (otherwise this does not make sense).

- Eq. 9 What is Qj and what is N- the number of different "outlets"?

- I have problems with the terminology of a "StorAge selection" function (even if it is established), as the stream doesn't do an active select water of different ages.

- Preferential flow does not necessarily mean that Peclet number is large, if the flow is still in the near field and mixing among the flow paths is small. There is literature evidence for this.

- Eq. 6 - 8: Z is a Gaussian random number, otherwise the coefficient in below the root is 1/6.

- Parts of the section 4.1 should be shifted into the methods section!

- Page 14: Figure 5 is a scatter plot of heads (simulated and observed) not of the head residuals.

- Page 6 line 5: Repetitive statement on the TTD of the soil?

- Not sure what is meant with "backward travel time distribution"?

- Page 8 line 20: how are they interpolated?

- Figure 1: Caption is not self-explaining: what is mo, mu, mm etc?

- Table 1: Please explain km and ku.

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-What is the estimation variance of the mean you calculated (based on the standard deviation and the sample size) , might be nice to add this to Figure 8.

- I think the paper would greatly benefit from a thorough proof reading.

Best regards,

Erwin Zehe

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