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Hydrology and Earth System Sciences
Discussions

Interactive comment on "On the Conceptual Complexity of Non-Point Source Management: Impact of Spatial Variability" *by* Christopher Vincent Henri et al.

Anonymous Referee #1

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Overview:

This is an interesting work that brings together many contributions in the field of probabilistic risk assessment (PRA) in aquifers to investigate transport of non-point sources (NPS). The authors explore parameters such as recharge rates and contaminant loadings in the final model output. Furthermore, the authors attempt to reduce the complexity of the model by upscaling a set of spatially/temporally variable quantities, such as the hydraulic conductivity, on the management of NPS. Through the use of numerical simulations, the authors provide an analysis that couples vadose zone, aquifers and land use in a single framework.

I enjoyed reading this paper given that it aims in bringing in elements of stochastic hydrogeology into decision making. The material is well written and organized. The illustrations are clear and well depicted. The referencing is also appropriate although some contributions in the PRA of contaminated aquifers are missing. This is not a big issue. Through the use of scaling arguments (i.e. compliance planes, source sizes etc) the authors make a compelling argument to evoke upscaling for the problem at hand. They claim that due to significant mixing in the compliance plane and the lack of significant variability in NPS solutes, the uncertainty in predictions are reduced thus leading more simplified approaches for modeling such complex systems. Results indicate that the mass arrival time distributions are not that sensitive to the spatial variability of recharge and solute loading whereas some sensitivity is observed for the concentration signal and capture zone estimation. The authors also show that homogenization of the conductivity affects the uncertainty of arrival times.

Specific comments:

-The authors refer to the word ergodicity multiple times. Ergodicity in what? I think they are referring to ergodicity in the transport behavior. If so, provide a quantitative measure of what ergodicity is. For example, the ratio between the source zone dimension and correlation scale needs to be large. If this is the case, than why one would need to quantify uncertainty due to the conductivity field? The spatial statistics is representative of the ensemble statistics. This needs to be better discussed.

-I am not sure if I missed this in the text but it would be interesting to see if the upscaled dispersion reaches its Fickian limit. Looking at figure SM6, it seems that this is not the case and therefore, transport is still subject to uncertainty. To my understanding, based on the histograms, these upscaled dispersion coefficients reported in figure SM6 are not the ones in the Fickian limit and therefore ergodicity is not attained. So how is it that the authors claim "ergodicity" in this paper?

-It would be interesting to see how the conclusions regarding recharge reported in this

paper compare with the ones reported in the works of Rubin and Bellin (1994) WRR and Li and Graham (1999) WRR. These authors investigate the impact of recharge and its randomness on travel time pdfs.

-Line 460: “The results here confirm that…, but also put the macro-dispersive process…”. I could not understand the meaning of this sentence. Please revise its structure. Thanks.

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