

# ***Interactive comment on “Quantifying Vertical Hyporheic Exchange and hyporheic residence time in thalweg paths of meandering streams characterized by multiple riffle-pool sequences morphology” by Aminreza Meghdadi et al.***

## **Anonymous Referee #1**

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The manuscript submitted by Meghdadi et al. deals with the application of natural tracer and temperature to quantify hyporheic exchange fluxes for riffle-pool systems. Although the overall topic is very interesting and the presented data shows some good potential, the manuscript suffers from some major flaws. Especially how the data was used to quantify hyporheic exchange is highly questionable and in my opinion not acceptable for publication. In addition the manuscript in some parts is poorly structured and the presented figures are very confusing and of poor quality. Therefore I cannot recommend the presented manuscript for publication in HESS. Major Comments:

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1) Temperature method The authors used vertical temperature profiles to quantify hyporheic exchange based on a steady state assumption (Equation 2). At the same time data (diurnal temperature fluctuation) is presented (Figure 6) clearly showing that this assumption is violated. Here I think the unusual high exchange fluxes  $>1$  m/d may result from the violation of steady state assumptions. 2) Radon method Beside temperature the authors used vertical Radon profiles to quantify hyporheic exchange. Based on the presented equations (Equation 5) and the presented data it is a very unclear to me how to derive upward fluxes using Radon. Under strictly 1D assumptions upward fluxes require a Radon profiles where the Rn activity is increasing towards the streambed interface (young water in the depth and old water at the streambed interface). For example for site B7 the Rn profile indicates in Figure 6 indicates that the water age is increasing in depth. Under 1D assumption this indicates infiltrating conditions and a negative flux, however the authors present an upward flux. And almost all of the presented Radon profiles look like this. Also how did the authors distinguish between water from the hyporheic zone and groundwater inflow? 2) 1 D Assumptions Hyporheic flow fields are known to be quite complex and three dimensional in nature. Hyporheic flow is influenced by 1) the hydrodynamical conditions in the open channel flow, 2) scale depended characteristics of the streambed and 3) interactions with the regional groundwater flow. Further hyporheic flow in general is known to be three dimensional in nature. Many studies that deal with the hyporheic zone do use 1D assumptions but mostly this is used to estimate fluxes for shallow areas of the streambed ( $<10$  cm). The authors evaluated temperature and Radon profiles taken from 1m deep wells using 1D assumption. At this depth lateral flow components can't be neglected as also lateral groundwater flow might be important at this depth (which is also mentioned by the authors).

3) Numerical model There are many modelling studies available that are trying to represent hyporheic fluxes accurately as a function of the morphological conditions of the streambed. Almost all these modelling studies mention that, beside an accurate representation of the streambed topography, the pressure variations along the streambed

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are necessary to predict hyporheic exchange patterns. The numerical approach, which is only poorly described in the methods chapter, represents river flow in a very simplified manner by applying source terms. Does that mean that the authors need to explicitly specify whether the stream loses or receives water from the subsurface? If this is the case the whole simulation with the purpose to predict in- and exfiltration areas and associated fluxes does not make sense as it is already pre-defined in the model setup. Minor comments Please add consecutive line numbers. It is hard to address issues in the manuscript without them. Page 2 line 22: Explain meaning of kinematic zones. Page 3 line 3: Hydrodynamic conditions in the stream are also known to be important for hyporheic exchange. Page 4 line 17: I would not describe a 10 years old study as a recently published study. Page 4 line 19: replace "In other study,..." with "In another study,..." Page 5 line 1: remove "recently" Page 5 line 4: The whole paragraph fits better into the methods chapter Page 5 line 4: Remove "recently" Page 5 line 4: What do you mean with "...it employs a set of differential equations..." Page 5 line 23: What do you mean with "apply the vertical variations of diel temperature..." Page 6 line 11: What is a "dominant geochemical unit"? Page 7 line 21: replace "calculated" with "measured" Equation 1: I know this equation only using  $v=q/n$  ( $n$ =porosity) as the advective velocity. And please add SI units for the different components Equation 2: This is a steady state solution and is not directly result from equation 1. Please add made assumptions. In general the entire methods chapter needs revising as much more detail has to be provided. Equation 4: please add units (for all equations). Page 10 line 15: What is "ID" Page 10 line 15: I do not understand the meaning for the sentence beginning with "As an assessment ...." Page 11 line 1: Add "The" at the beginning of the sentence. Equation 5: Units Page 11 line 21: Was this equation ever used before in a similar fashion? PHAST modelling section: The whole chapter needs much more information 1) about the code 2) the numerical implementation, 3) how river flow is presented and 4) the applied boundary conditions specifically the lower boundary. Is it no flow or is there some kind of groundwater inflow? Also a much better explanation is needed why and how the authors "transformed the river boundary conditions into

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source terms". Results and Discussion: Usually I prefer that Results and Discussion are two separate chapters. Page 13 line 11: What do you mean with "...33 testing points along the riffle-pool sequence of the meandering river where identified". Also the entire paragraph better should be shifted into the methods chapter. Table 1: what does the 10 mean in column Z4 Page 16 line 7: I think Cardenas never worked on a river in Iran. Page 16 line 12: This sentence sounds like that the authors assume that Radon is the reference method obtaining accurate estimates for hyporheic fluxes. Page 16 line 17: Groundwater inflow also does influence the in-stream Rn activity. Page 19 line 2: Which difficulties? Page 19 line 6: "...to asses the operational accuracy of the simulator against temperature and radon.." This statement implies that estimates from the temperature and radon method are accurate. Page 19 line 10: The whole paragraph should be shifted to the methods chapter. Figure 1: The whole figure is very confusing with too much sub-plots. Figure 2: Why are the plots all differently sized? This is kind of sloppy. Also remove the frames Figure 4: This Figure is also hard to read please present differently Figure 5: see above Figure 6: Profile plots are too small. Maybe less profiles are the better option Figure 7: see above Figure 8: see above Figure 9: Again very sloppy. Each of the plots are differently sized.

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