Hydrology and Earth System Sciences Discussions

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
https://doi.org/10.5194/hess-2021-293-RC2, 2021

Comment on hess-2021-293

Stefan Ploum (Referee)

Referee comment on "Combining passive and active distributed temperature sensing measurements to locate and quantify groundwater discharge variability into a headwater stream" by Nataline Simon et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-293-RC2, 2021

This study investigated groundwater-surface water exchanges along a headwater system, through the use of both passive and active thermal methods. The goal of this study was to quantify spatiotemporal variability in groundwater discharges to streams, which is an important and timely challenge. The authors have presented a novel combination of field data, which consisted of both active and passive use of FO-DTS (fiber-optic distributed temperature sensing), vertical thermal profiles, and hydrometric data. While this study seems to fill an important knowledge gap in the quantification of groundwater-surface water exchanges, the manuscript is for a large part focused on relative differences and qualitative evaluation of the observed thermal gradients. Similar to Reviewer 1, I suggest to develop the parts regarding quantification of GW fluxes/seepage rates. As such, I consider this study appropriate for HESS audience and to be publishable after considerable revisions.

In general, the manuscript is well structured, and reads pleasantly. The language is descriptive and engaging, which helps to tag along with the implications and meaning of the observations that are presented. I would recommend to more clearly provide a research question and/or hypothesis to understand what is tested and what the concrete outcomes are. In the current state I have the impression most of the manuscript is interpretation of observations, which are then coupled to potential explanatory factors. As such, the manuscript leans heavily on relative comparison of standard deviations of thermal records and interpretation thereof. While this is interesting and helps to understand the system that is studied, the novelty of the manuscript lies in the combination of active and passive DTS measurements and the eventual goal to quantify groundwater fluxes. The latter unfortunately has been covered quite sparsely. Therefore, I would recommend to compress the interpretation of relative differences in temperature/SD, and leverage the quantification of fluxes such as in Figure 9, which I found personally the most compelling aspect of this paper. Also the approximation in section 4.2 of relative GW contributions to total discharge could be further expanded (L565), and could make this study more enticing. However, to develop the quantitative aspect I believe that the underlying assumptions (e.g. 1D model of thermal gradient and homogenous stream T) need to be part of this expansion. Further, the discussion is for a

large part evaluating methodological limitations, which are of interest but leave little space for a more broad interpretation of the results and contextualizing the presented work. In the discussion it would be interesting to read more on the relationship between spatial distribution of soil/sediment, thermal conductivity, hydraulic properties and implications for the DTS observations. Also linking this heterogeneity in and around to stream channel to heterogeneity of the landscape and riparian zone could be an interesting topic of discussion. While I think that the first part of section 4.3 was going in this direction and could be further expanded and complemented with e.g. hydrological connectivity (for example Jencso et al. 2009, doi:10.1029/2008WR007225)

Further, I like to address a number of technical details and/or text edits. Below I have provided some by line number, but they might apply to the entire manuscript (e.g. consistent use of units or language). While the paper reads pleasantly, there are some consistent language errors that are a little bit distracting or could be confusing. However, as I am not a native speaker, take my suggestions with that in mind and maybe double check with others.

- L11, L15 and further: "consist of"
- L14 and further: unsure of the use of punctual here and elsewhere. I suggest point measurement but this depends on the use.
- L23: On the opposite -> contrary
- L25: the end of the abstract dies down a bit, is there a more compelling way to conclude this work?
- L90: as mentioned I would suggest a more concrete research question. The aim to discuss a certain topic feels like a misfit with the data that is available and the eventual goal to quantify fluxes.
- L92: For doing so => To do so
- L100: achieved on => conducted in
- L104: researches => research
- L104: consider revising the sentence to something like: "This site was selected because it had the advantage of readily installed equipment, for monitoring and experimental studies (Fovet et al 2018)."
- L108: higher slopes => steeper slopes
- L109: was the wetland developed my people? If natural, I would suggest to change was developed to e.g. "is positioned" or "is situated"
- L110: This is a man-made environment where... => In this man-made/anthropogenic environment the stream…
- L112-L114: This made me wonder what type of drains these are? I would argue that rain water that is quickly routed through the shallow soil layers into belowground drains could still be considered as a form of groundwater given that it chemically and/or thermally has been affected by this short residence time belowground. In the light of spatial heterogeneity of GW-stream interactions this might be an important nuance (e.g. Hester and Fox 2020, doi/10.1029/2020WR028186)
- L123: precipitation is
- L124: Reference for previous studies, and "on average"
- Figure 2: suggest to change line types for colorblind people. This could be good to improve in other figures too, but see where you find the opportunity.
- Figure 2b: the lag between thermal signals would almost suggest to me that there is recharge rather than discharge in the riparian zone. I think Reviewer 1 has expanded on this more, but I think it should in general be clear whether gaining or loosing conditions apply, and what the implications are for the GW fluxes and the methods

used. Especially since the 1D approach does not provide a clear direction but only rates, this can be an important issue.

- L145: achieved => conducted
- L148: suggest to change to "the average burial depth was estimated to be 8 cm"
- L152: thicker => deeper? I think this is personal preference
- L165: Are there at the vertical profiles also coils of DTS cable that allow some form of comparison?
- L172: Suggest to start with: "Groundwater inflows can be detected by…
- L187: the assumption of the homogenous stream temperature applies to only at the VTP? To me this sounds like you assume homogenous temperatures along the reach, which for obvious reasons would be a quite bold assumption.
- L201: this reads as results and therefore comes as a surprise. Maybe consider rephrasing or remove the first lines.
- L231: I think the data interpretation section can be merged with the previous one.
- Figure 4: is the red line indication an average stream temperature of 1.38 not a point (around 500 meter if I'm correct?)
- L270: local spikes or dips or anomalies? Peaks would imply that it always goes up
- L271: associated with (also line 273), very run on sentence
- Figure 5: in the text panel b is discussed first, then panel a. Maybe take this into account when revising
- L308: quite similar temperature variations is unclear, consider rephrasing. In general I would recommend to make the language used in the results more "absolute" where this is possible.
- L338-L340: "values of" can be omitted
- L341: d implies depth but refers the distance? Maybe consider length (l)?
- L355: "Regardless of" might be more suitable than "Whatever the uncertainties"
- L364: the experiment
- Section 3.2 and elsewhere: I suggest to express the GW fluxes in m/d since in m/s values are so low it is difficult to imagine
- Figure 10: maybe consider splitting up the figure, since there is a lot going on.
- L480: rephrase "conclude about"
- L482: not sure if I follow the thought about needing 3 DTS cables, this seems like an practical issue that is relevant, but maybe I'm missing something
- L563: which hypothesis?
- L565: I like this part a lot, and I think this can be used to improve the results and lead towards interesting discussion topics such as the link between quantification of fluxes and longitudinal heterogeneities such as gaining/loosing conditions, hydraulic properties, topography etc. etc.
- L641: This section confused me a bit and I would remove long-term. Typically DTS systems are expensive to run for longer periods, and characterization of a reach (and detection of groundwater inputs) could be achieved by short deployments during contrasting hydrological conditions and seasons. Actually I would consider it a more logical end of the discussion to suggest that active DTS experiments need to be considered rather than passive long-term deployment, to move from the interpretation of thermal gradients towards quantification of fluxes.
- SI: L69: section 3 header says passive which should be active? Figure S4, panels b and c: Does power outage refers to termination of the experiment? Now it reads as a cut-off of the power supply, but I assume it is the moment the heat was turned off.