Dear Miriam Coenders-Gerrits,

Thank you very much for your feedback and for considering our study as a potential publication for HESS. We appreciated that the reviewer agreed to review for the second time our manuscript and we thank him for his time.

Please find below a detailed point-by-point response to reviewer's comments. We carefully answered to every single comment/question addressed and also considered the few comments he made in the attached document.

Thank you for your time,

Kind regards,

Nataline Simon & co-authors.

Response to the comments of Bas des Tombe

Dear Bas des Tombe,

First, we would like to thank you very much for accepting reviewing once again our manuscript and for your comments. Please find in the following, a point-by-point response to your comments. Your comments are *in italics* and the responses in regular text.

Kind regards,

Nataline Simon & co-authors

- Remove the suggestive claims that certain dynamics of variability in seepage flow are measured with the passive method. That would require multiple seasonal cycles, while the measurement period here is 8 months.

Indeed, the passive-DTS measurements were "only" conducted for 8 months. It is true that it is not sufficient to fully investigate the temporal pattern of GW discharge. However, it appears that these 8 months of monitoring are enough to highlight temporal changes in groundwater discharge. This is what we show in sections 3.1.1 and 3.1.2. The analysis of time temperature series (3.1.1) and the model used to quantify flow from passive-DTS measurements (3.2.1) both suggest an increase of groundwater discharge in winter (induced by the increase in precipitations that contribute to increase hydraulic gradients) and a decrease in spring (in agreement with the decrease of the groundwater table). This point is widely discussed in the discussion section (4.3). Therefore, we are convinced that we are actually able to highlight a certain dynamic in seepage flow.

However, as you mention in the attached document, the sentence "Long-term passive-DTS measurements turn out to be an efficient method to detect and locate groundwater discharge along several hundreds of meters to investigate the temporal pattern of

exchanges over the annual hydrological cycle" is probably too general and not enough precise. Thus, this sentence is now improved in the revised abstract:

". Long-term passive-DTS measurements turn out to be an efficient method to detect and locate groundwater discharge along several hundreds of meters. **The continuous eight-months monitoring allowed highlighting changes in the groundwater discharge dynamic in response to the hydrological dynamic of the headwater catchment**"

- Claims of the authors being the first to attempt active heat tracer tests with DTS in stream/river beds to quantify flow are simply not true. https://www.mdpi.com/1424-8220/20/19/5696/htm#B65-sensors-20-05696 / https://hess.copernicus.org/articles/19/2663/2015/hess-19-2663-2015.pdf

We are sorry to read this comment because we didn't intend to claim that we were the first to attempt active heat tracer tests with DTS in stream/river beds. Thus, the second reference you mention here (Kurth et al. 2015) is referred in the introduction (from L. 95 to 98): "Despite promising developments, active-DTS methods have been seldom used in hydrology to estimate groundwater/surface water interactions. Kurth et al. (2015) coupled passive- and active-DTS measurements and highlighted areas with lower and higher flow rates over the cable…". However, in their study, Kurth et al. (2015) do not go as far as us since they don't use active-DTS measurements to quantify fluxes. In their study, active-DTS measurements are only used qualitatively to locate lower and higher flow rates. This is why we add then in the text: "…but the quantification of fluxes remained unexplored."

However, as you mention in one of the comments in the attached files, the following sentence in the abstract: "On the contrary, active-DTS measurements, which have never been in streambed sediments up to now…" is not exactly true since active-DTS measurements have actually been conducted in streambed (but not to quantify fluxes). Thus, this sentence was improved in the revised version (L. 22 in the abstract): "On the contrary, active-DTS measurements, **which have seldom been performed in streambed sediments and never applied to quantify water fluxes** …"

Concerning the first reference you mention (Ghafoori et al. 2020), we are a little surprised about this comment. This paper deals about the use of DTS measurements to detect and quantify seepage flow through embankment dams. Such application is very different from the one proposed here. Note however that this study is already referred in the introduction section (L. 92) when we introduce previous applications of active-DTS methods.

- Punctual measurements -> point measurements

Term "Punctual measurements" is used in the manuscript for two different purposes.

- Firstly, the term was used twice concerning active-DTS experiment (we used the term "punctual active-DTS measurements" to indicate the experiment was performed punctually in time). In this case, this term was removed in the revised manuscript and associated sentences were rephrased. Instead of speaking about "punctual active-DTS

measurements", we now precise in the revised manuscript: "the active-DTS experiment, performed during few days **…**" (L. 16 and 285).

- Secondly, the term was used twice in the abstract concerning the Vertical Temperature Profiles. In these cases, the term "punctual measurements" was replaced by "point measurements" as suggested (L. 58 and 80 in the revised manuscript).

- The flow rates can be so high that thermal dispersion, thus a velocity dependent diffusion term, heavily affects the flow estimates. (specific discharge >~ 0.5m/day)
- Thermal dispersion is still left out of the equation, even though flow velocities are high (q>~0.5m/day).

In our case, we consider that it is not necessary to consider thermal dispersion effects since a single FO cable is used during the active experiment (no transport between the heat source and the FO cable). Incidentally, studies presenting active-DTS measurements conducted with heated FO cables – for instance Munn et al. (2020), Maldaner et al. (2018), Coleman et al. (2015) or else Bakx et al. (2019) – do not consider neither this parameter. However, while an independent heating cable is used as heat source (Bakker et al. 2015, des Tombes et al. 2018, among others), it is certain that thermal dispersion effects can affect flow estimates, especially for large values of specific discharges.

- And the estimates of the passive test seem to be heavily dependent on the value chosen for the thermal conductivity.

This is absolutely correct. For passive-DTS experiment, flow estimates are highly dependent on the thermal conductivity. Actually, this is one of the main conclusions of this study. We demonstrate that flow quantification from passive-DTS measurements is highly limited because of the uncertainty on thermal conductivities. This is why, we propose to assess the effect of thermal conductivity on flow estimates (for instance in sections 3.1.2 and 3.3). This point is clearly considered in the conclusions of the study and detailed in the discussion section (see the section 4.2.1):

"Last but not least, results showed that thermal conductivity values have a very strong impact on fluxes estimates, which is consistent with the results of Briggs et al. (2014), Duque et al. (2016), Lapham (1989) and Sebok and Müller (2019). The lack of knowledge and assumptions on thermal conductivities values lead to high uncertainties on fluxes estimates using both VTP and passive-DTS measurements (Fig. 6b). In-situ estimates of thermal conductivities using thermal conductivity probes could considerably improve the fluxes estimates, as demonstrated by Duque et al. (2016), who reported up to 89% increase in flux estimates when using in situ measured sediment thermal conductivities. However, seeing the high spatial variability of the thermal conductivity highlighted through the active-DTS experiment, it would certainly require a tremendous effort in the field to characterize such variability with single probes. Moreover, it will not remove others sources of uncertainties associated to the burial depth of the FO cable or to the lack of temperature measurements at different depths all along the section."

Nevertheless, we also demonstrate that coupling passive-DTS measurements with active-DTS measurements can be an efficient way to counter this limitation. This is discussed in section 4.2.3 and is one of the main conclusions of the study.

- All measurements were performed in a river that is gaining. Both passive and passive experiments suffer more from the false boundary conditions in rivers under losing conditions. A gaining river gains water with a nearly constant temperature, in a losing river the water temperature can fluctuate wildly. The title and the scope of the presented manuscript should be limited to gaining streams. The word "into" in the title is, in my opinion, not sufficient and I would propose to add the word gaining to the title.

We have to say that we are a little surprised with this comment, especially because you already raised this point in your previous review. At this moment, we completely agreed that this point deserved to be improved. Thus, in the revised manuscript we submitted in December, we significantly improved this.

First, we changed the title of the study. According to us, this is clearly expressed starting from the title that the study focuses on gaining conditions:

"Combining passive- and active-DTS measurements to locate and quantify **groundwater discharge** variability **into a headwater stream**"

Indeed, the title includes two terms ("groundwater discharge" and "into a headwater stream") that are both related to gaining conditions (and no confusion is possible here).

Moreover, significant changes were made to improve the abstract. Thus, the two first sentences of the abstract also clearly introduce this point: "Exchanges between groundwater and surface water play a key role for ecosystem preservation, especially in headwater catchments where **groundwater discharge into streams highly contributes to streamflow generation and maintenance**. Despite several decades of research, investigating the spatial variability of **groundwater discharge into streams** still remains challenging mainly because groundwater/surface water interactions are controlled by multi-scale processes."

Then, a bit further (4th sentence of the abstract), the scope of the study is explicit: "To do so, we propose to combine, for the first time, long-term passive-DTS measurements and active-DTS measurements by deploying FO cables in the streambed sediments of a **first- and second-order stream in gaining conditions**."

- Please have a look at the few comments in the attachment

Thank you for the comments in the attached file, which allowed improving the abstract in particular and correcting some spelling mistakes and typing errors.