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The Cryosphere Discussions

Interactive comment on "Estimating interaction between surface water and groundwater in a permafrost region using heat tracing methods" *by* Tanguang Gao et al.

Anonymous Referee #1

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GENERAL COMMENTS

The manuscript presents a case study using temperature-based methods to detect the direction and magnitude of groundwater upwelling or downwelling through the beds of a large river in China. The authors used two methods, namely the analysis of diurnal temperature fluctuations using the standard one-dimensional heat transfer equation, and the delineation of temperature anomaly using a fiber optic distributed temperature sensing (DTS) device. Both of these method have been well established and widely used in similar studies. It is an interesting attempt to use these methods to understand surface water – groundwater (SW-GW) exchange processes in permafrost

environments. A study like this has the potential for making a useful contribution to improved understanding of permafrost hydrology. However, I find that this particular manuscript does not demonstrate sufficient rigor and merits to warrant publication in The Cryosphere. This is mainly because: (1) it lacks novelty in the application of the temperature-based methods, which have become standard tools in SW-GW interaction studies, (2) the methodology appears to have deficiency, and (3) the results are not particularly relevant in the context of permafrost hydrology. I will elaborate more on these in my specific comments below.

SPECIFIC COMMENTS

Equation 1. The standard convention in the SW-GW interaction literature (i.e. those cited by the authors) is to use the z-axis to indicate depth, not elevation. Since the authors do not define it differently, the reader would assume that the z-axis is positive downward. Therefore, a positive value of velocity indicates downward flow, and a negative value indicates upward flow. This is opposite to the authors' interpretation of flow direction (P7, L19). This calls the validity of the results into question.

P4, L27. Since the publication of Lautz (2012) and Rau et al. (2015), further advances have been made in analytical methods and tools for diurnal temperature signals. Without more rigorous efforts to quantify the Darcy flux, this manuscript stops short of meeting the standard expected for SW-GW interaction studies published in a referred journal. Since one of the two objectives of this study is to "test the validity of the heat tracing methods in permafrost hydrology" (P3, L3), it is critical that the authors use the best and the most current method for data analysis.

P4, L31-P5, L1. I question the validity of this approach. The foundation of the analysis of diurnal fluctuations is Equation 2, which assumes harmonic temperature signals having a frequency of 24 hours. The peaks and troughs picked in the time domain are influenced by non-diurnal components of the temperature signal, which is not compatible with Equation 2. If the authors do not want to use the harmonic analysis, a proper

approach would be to use a numerical model to solve the heat transfer equation and optimize the solution (e.g. Constantz 2008).

P5, L30. Looking at Google Earth images of the study sites, I get a sense that this is a major river with a substantial channel width. How do the sensors located only one meter from the stream bank represent the SW-GW interaction in the river? It will be useful to include the essential information about the river, such as discharge hydrograph, as well as depth, width, and velocity at measurement points.

P6, L4-6. It has been widely shown in the literature that the contact between DTS cable and stream-bed sediment is critically important. I do not believe that the method described in these sentences ensures that the cable is actually measuring the stream bed temperature, not the temperature of water flowing just above the stream bed. Figure 5 seems to indicate that the cable is sensing the temperature of flowing water, not the temperature of pore water at the stream surface.

P7, L20. I am not sure if the authors' interpretation of the sign of velocity is correct (see my comment above). It is unusual to have a large river like this losing water at all the sites during the wet season.

P9, L24. I do not understand how the stream bed temperature exposed to flowing water can fall much below zero (-2 C in Fig. 2c) during summer months. Were the temperature sensors properly calibrated?

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