January 20, 2014

Dr. Markus Hrachowitz
Handling Editor
Hydrology and Earth System Sciences

Dear Dr. Hrachowitz:

Please find enclosed our revised manuscript. We have revised the LaTeX source file:

`'hess-2013-451-discussions-typeset_source-version2.tex'`

which was uploaded by Copernicus on the Editor Portal. Some of the preamble LaTeX commands used by Copernicus cannot be compiled on my version of LaTeX. I decided not to alter these commands; therefore, there are a few formatting issues with the author names and section headers in our revised pdf file. However, these should have no impact on the actual content and the .tex file should compile correctly by Copernicus.

The following is a list of changes to the manuscript:

- We have clarified our categorization of the energy fluxes. We have added the following text at the beginning of section 3.2 "Note that the term 'surface energy fluxes' is defined as net radiation, sensible and latent heat fluxes occurring at the stream surface; 'vertical energy fluxes' is defined as surface fluxes, bed heat conduction, and stream friction; and 'lateral energy fluxes' is defined as advective fluxes from overland flow and throughflow." We have also changed any related text within the document to be consistent with this terminology.
- Section 3.2.5 'Stream Energy Budget' has been renamed 'Lateral Heat Fluxes Calculated as Residual of Stream Energy Budget'.
- Figures 3, 4 and 6 have had their axis ratios altered slightly to display the temporal patterns more clearly, while working within the figure size constraints of Copernicus Publishing. We have changed the discharge plots in Figure 3 to log scale.
- Figure 4. We have added the following to the caption: 'Note the difference in scales of the total heat fluxes and the vertical components'.
- In order to improve the clarity of the manuscript, we have included a reference to the corresponding sections (3 and 4) on page 12955 where we first mention how the study hypotheses are addressed with the energy budget (Sec 3) and historical (Sec 4) studies. We have also included further text at the beginnings of sections 3 and 4 to help guide the reader through these separate but complementary studies.
- We have included a clarification that we made spot measurements of vertical hydraulic gradients and temperatures of the streambed in order to evaluate our assumption that hyporheic energy exchange and bed heat conduction are secondary heat budget terms.
- Regarding the hyporheic term, we have add details in Section 2 on the stream morphology. We have also provide further details in Section 3.1.5 on the piezometer measurement methods, and included additional discussion in Section 5.1 about the uncertainty and challenges associated with estimating the hyporheic energy flux.
- In Section 2 we have included the range of channel wetted widths. We have also mentioned the high relief of the catchments, which provide substantial topographic shading of the stream. We have included mention that the channels are not heavily incised and shading from channel banks is minimal.
- We haved added to the manuscript that at four step-pool sequences, a piezometer was placed upstream

of the step and downstream in the pool, that piezometers were located in the centre of the channel, and head measurements were made with an electronic beeper, which has previously been found to be accurate to +/- 5 mm (Guenther 2007).

- We have clarified in the revised manuscript that twenty-two locations had three thermocouples and three locations had two thermocouples, due to the shallow depth of bed sediment, and thermocouple installation depths varied by location.
- We have revised the manuscript to try to make more clear that the threshold value to binarize the hemispherical images was calibrated by comparing observed incoming solar radiation from the two above-stream pyranometers with modelled incoming solar radiation using hemispherical images captured at the pyranometer locations.
- We have clarified that Jadv is calculated based on the difference in J at the lower and upper reach boundaries calculated based on ten minute values. We did not explicitly account for travel time along the reach, but we did calculate the change in storage heat within the reach over those ten minute time intervals, which was found to be negligible. We have revised the ms to clarify this point.
- We have clarified how the net radiation model was evaluated against roving measurements of net radiation.
- To section 3.2.2, we have added 'For bed heat conduction calculations, temperature gradients between the stream and bed were small during all spot measurements and across all locations.' to clarify that bed heat conduction is based on spot measurements.
- We have added the following to section 4 to highlight the complementary nature of the historical study: 'The historical study complements the energy budget study by addressing the role of snow cover on stream temperature during rain events by extending the limited period of study of the detailed energy budget analysis and sampling more precipitation events over variable snow and weather conditions.'
- We have included additional details on the stream temperature monitoring. The following information was added to Section 3.1.3 and Section 4.1: "The time interval for temperature logging was 15 minutes. Temperature loggers were cross-calibrated at 0 deg C (ice bath) and room temperature, before and after field deployment. The stream temperature loggers were also routinely checked in the field using a WTW 340i handheld conductivity and temperature meter and found to be within the stated accuracy range of the loggers."
- On page 12967 l 21, we clarified that stream temperatures reported here are mean hourly temperatures. We also provided information on the average and max/min diurnal temperature range for the Q1 stream temperature site.
- In Section 5.3 we have included a short discussion on the potential impacts of increases in winter precipitation may have on the winter stream thermal regime.
- In Section 5.3 we have included a sentence that links potential thermal impacts on aquatic invertebrate emergence timing to terrestrial food webs.
- We have updated three references that have been assigned volume and page numbers since our initial submission (Guenther et al 2014, MacDonald et al 2014, Bulliner and Hubbart 2013).

Sincerely,

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