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Interactive comment on "Principle components of thermal regimes in mountain river networks" *by* Daniel J. Isaak et al.

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General comments This manuscript presents an elegant analysis of different components (magnitude, frequency, duration, timing) of thermal events for a large number of time series points in the United states. Two variations of Principal Components Analysis (T-mode and S-mode analyses) refine the analysis very nicely into spatial regions and temporal seasons of thermal homogeneity and seasonality. By disaggregating time series into metrics, and accounting for high levels of redundancy between metrics, together with the PC analyses, this research presents a novel approach to optimising site locations for water temperature gauging networks. In my opinion, this is a very useful addition to thermal research in lotic systems. The approach is generic and applicable to a global audience. The manuscript is clearly and well written, methodologically elegant

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and scientifically sound. I recommend publication given minor comments corrected below.

Our response: We much appreciate the reviewer's kind words and attention to detail in their comments. We are willing to make many of the suggested revisions as described below.

Specific comments Section 3.1 – Does one need to specify that the study assumed stationarity in the data, in order to generate temperatures for 365 days based on five-year time series?

Our response: There has been some focus in the recent literature on the possibility of nonstationary responses in stream temperatures due to climate forcing. However, that type of nonstationarity is generally expected over multi-decadal timespans and the prediction is based largely on mechanistic models rather than documentation from empirical trends in monitoring datasets. During the short five year study period we considered, nonstationarity was unlikely to be important and the 12% of missing daily observations were reconstructed from nearby sites with strong covariance using the missMDA statistical package in R.

Line 207 – Please provide a summary of the environmental gradients; it may be worth including a table on these.

Our response: Table 1 would be expanded to include summaries of these gradients, which were elevation, drainage area, annual flow, and reach slope.

Line 212 – Please explain why the thermal year started on 1 December. In South Africa, we typically use 1 October – 30 September for the Hydrological year, but I am aware that this varies regionally, being based on the onset of the highest discharge season.

Our response: The water year in North America is also considered to start October 1 but in the climatological literature, seasons are slightly different and considered to

be winter (Dec/Jan/Feb), spring (March/April/May), summer (June/July/Aug), and fall (Sept/Oct/Nov). Climatological considerations seemed more relevant in the present context, and the conventional three month seasonal periods also conveniently matched the water temperature patterns common to our study site. We describe our rationale for starting the thermal year on Dec 1 in the manuscript where we state "We started the thermal year on December 1 because temperatures usually reach their annual lows by this date and the 3-month period thereafter constituted a logical winter season (i.e., December, January, February)."

Line 234 – It would make more sense to me to represent the thermal gradient per 100m. This would be a useful figure in defining a water temperature lapse rate. For air temperatures, this is typically expressed as something like 0.7°C per 100m.

Our response: We agree and are willing to revise the values in Figure 2 accordingly.

Technical comments Title and elsewhere in text: please check for correct spelling of "Principle [as in components]", which needs to be corrected to PRINCIPAL and checked throughout text, as there are instances of both. Nothing serious – I get confused between these two spellings!

Our response: Embarrassing on our part that we missed this. Inconsistent usage will be changed to "principal" throughout.

Lines 37-40: Sentence does not read well. Suggested revision "Knowledge of the local thermal regime, based on the annual sequence of temperatures characteristic to specific locations within a river network, is key to understanding natural conditions and diagnosing anthropogenic impairments."

Our response: This revision would be made.

Lines 62-64: Suggested revision "While that may bring..., most warm stream...correlated with each other and therefore redundant. If redundancy is also reflected across a broader..."

Our response: This revision would be made.

Paragraph beginning line 146: Be explicit that these time series refer to water temperatures, as later on in the manuscript air temperatures are also used.

Our response: This revision would be made.

Line 218 – “sites, an S-mode”

Our response: This change would be made.

Line 253 – Figure 4a

Our response: This change would be made.

Line 257 – insert Figure 4c

Our response: This change would be made.

Table 1 – write US in full; standardise on number of decimal points down columns (also applies for Table 3).

Our response: United States would be spelled out. In the tables, we generally standardized on having two or three significant digits rather than the number of decimal points. We are glad to adjust this either way depending on the convention in HESS but have left the values unchanged for now.

Figure 2 – I like this figure! Please include the range of R2 values, and I would recommend that the caption explicitly describes the month(s) with the highest thermal gradient.

Our response: We are willing to add the R2 values to the figure but probably would not modify the caption to highlight a subset of months with the highest thermal gradients because we don’t think that information is inherently more useful than that for other months.

Figure 4 – caption revision to say “...show principal component scores for axes 1-2...”.

Please also check there are no other occurrences of “principle”.

Our response: These revisions would be made.

Figure 7 – “...and discharge (c-f)”

Our response: Caption would be revised accordingly.

References: Carlisle et al. 2017; Fuhrman et al. 2018; Isaak et al. 2016b; Josse and Husson 2012; Steel et al. 2017 not cited in text.

Our response: These errors would be corrected.

Inconsistencies in citations: Line 51 – Rieman et al 2015a; Line 80 Piechota 2001 or 1997?; Line 84 Gallacher 2016 or 2017?; line 90 Trumbo et al. Not referenced; line 175 – correct to R Development Core Team; Line 205 correct to SAS Institute Inc.; line 326 – spelling of Nusslé; line 352 – Jackson et al. 2017 or 2018?

Our response: These inconsistencies would be rectified.

Table 3 not cited in text.

Our response: An appropriate citation would be added.

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