

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

Daniel J. Isaak et al.

disaak@fs.fed.us

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This manuscript provides a nice analysis, characterizing the spatial and temporal characteristics and controls of thermal regimes of stream water. The work is based on a novel application of Principal Component Analysis, including the highly interesting differentiation of T-mode and S-mode PCA to illustrate both, temporal and spatial consistency of the stream temperature pattern. The paper is very well and concisely written, including a clear and complete description of the data and methods used. However and despite the flawless implementation of the analysis, the interpretation of the results and their implications remain somewhat superficial. After reading the manuscript, it seemed to me that the authors contented themselves with demonstrating how a well-known statistical tool can be applied with stream temperature data. The one finding

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that I found most interesting to demonstrate the value of PCA was that the authors could pin down the timing of the phase transitions. I may not see the forest for the trees but apart from that I am not sure what can be learned from the analysis. As far as I understand, the results essentially suggest that (1) stream temperature is mostly controlled by temperature magnitudes and lengths of winter periods (which again is related to temperature magnitude one would assume) and (2) stream temperature is more spatially homogeneous in winter than in summer. While the first does not really come as a surprise, it seems that the latter can also be inferred without PCA (or in other words: how is the information content of Figure 2 different to that of Figure 6?). I would thus be glad if the authors could invest a bit more effort in (1) highlighting the benefits of PCA with respect to other methods and (2) providing a somewhat stronger synthesis of their results – what are the novel aspects that can be learned from these results?

Our response: We agree with the overall critique that greater interpretation of results would be beneficial so are willing to expand the discussion in a subsequent revision. As for the reviewer's first comment that "(1) stream temperature is mostly controlled by temperature magnitudes and lengths of winter periods (which again is related to temperature magnitude one would assume)", the statement in the parenthetical clause is incorrect in conflating temperature magnitude with the length of the winter period. Our analysis reveals that these are instead two distinct aspects of thermal regimes in the mountain streams we studied. Streams with similar mean or maximum summer temperatures appear to vary considerably with regards to their winter period lengths when temperatures are largely homothermous. Exploring why that variation occurs would be a useful addition to a discussion revision. The reviewer's latter point that "(2) stream temperature is more spatially homogeneous in winter than in summer. [...], it seems that the latter can also be inferred without PCA (or in other words: how is the information content of Figure 2 different to that of Figure 6?)" is accurate but had previously been documented only at a few sites using time series plots like Figure 2. The T-mode PCA results put that site-level pattern into a broader context composed

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of hundreds of sites across large river basins. In this particular dataset, the thermal pattern across all the sites during the winter was largely consistent but that consistency was unknown prior to the analysis. Moreover, it is unlikely to be repeated in subsequent analyses we are planning with larger datasets that encompass greater climatic and hydrological diversity, so these PCA tools may help us identify subdomains regionally wherein stream thermal regimes behave differently. Here again, we think a revised discussion section can do much to bring out these points.

Technical comments: p.7,l.204: what is a “Princomp procedure”?

Our response: This was the statistical script run in the SAS software to perform the analysis. The reference to SAS could be moved forward in this sentence so it is adjacent to the “Princomp procedure” reference for clarity.

p.7,l.212: is there a specific reason to run the T-mode PCA on the 5-year mean values of the daily mean temperatures? In other words, why use 365 days (i.e. columns) and not the full data set of 1826 as in the S-mode analysis?

Our response: We judged it unlikely that appreciable inter-annual differences would be observed in the spatial phases revealed by the T-mode analysis given the large elevational gradient in the study area and because the dominant patterns in PC loadings were driven by cold and warm season cycles (Figure 5). Showing one annual cycle of tradeoffs between PC1 and PC2 was easier to present and read, so we elected to run the analysis on the 5-year mean daily values. However, we could rerun the T-mode analysis on the disaggregated series of 1,826 observations to confirm this assumption. We were less certain regarding the potential consistency of inter-annual variation in temporal patterns described using the S-mode analysis, so ran that analysis on the disaggregated water temperature records as well. In retrospect, the results based on the disaggregated records yielded similar insights as those based on the 5-year mean dailies, so little new information was gained except to re-enforce the fact that water temperatures respond strongly to variation in air temperature and discharge across a

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range of climate year conditions.

other than being repeated 4 more times in the plot of loadings. Displaying the pattern over the course the dominant annual scale variability should be more informative for readers and more easily grasped.

p.18,table 1: the values for reach slope seem excessively small. Should the unit perhaps be [m/m]? Please check.

Our response: Yes, the units were in m/m rather than % and the label will be changed accordingly.

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