Reviewer 2: Thank you for your helpful comments and the time you put into reviewing the paper. Below, our responses are provided in bolded text following each reviewer comment. The responses are primarily in the form of our plan to address each comment in a revised manuscript, if afforded that opportunity by the editor. We look forward to your further evaluation.

Laan et al. evaluated water column respiration (ERwc) and water quality parameters at 47 sites in the Yakima River Basin. The goal of the study was to identify factors driving changes in ERwc throughout the river network using LASSO regressions. In addition, the authors collected total and ERwc values from other studies in the continental US and the Amazon River basin. In general, the authors found no clear increase in ERwc over the course of the river network, and ERwc rates were influenced by local factors such as temperature, dissolved organic carbon, total dissolved nitrogen, and suspended sediment, rather than position in the stream network. In addition, the range of ERwc in the Yakima River Basin encompassed the entire range of ERwc that the authors found in the other studies, and ERwc contributed differentially to ERtot from the other studies.

Thank you for the encouraging remarks.

This study is well-focused and addresses a question regarding the processes occurring in the water column of river networks. The research is thorough and directed, leaving little room for criticism from my perspective. I'll leave two comments here that I would have liked the authors to address in a little more detail to see if/how relevant this might be to their study.

One point I am thinking about is the discussion of the importance of water column and sediment processes to overall metabolism. In line 22 of the abstract and several times throughout the manuscript, the authors state that "the relative influence of sediment-associated processes versus water column processes can fluctuate along the river continuum." In my opinion, an important factor in this statement is the greater influence of water column processes due to higher water levels when going downstream, which increases the areal influence of the water column. However, the authors compare volumetric rates, which do not consider the influence of water column height. Why did the authors decide to compare volumetric values? I'm not criticizing the approach, but I think the theory they are testing is largely based on this relationship. This could be a point that could (or should?) be included in the discussion.

One reason we looked at volumetric rates is that we did not have access to high quality depth data for all the field sites where we estimated ER_{wc}. To get good depth data would be a major effort in the Yakima River Basin. Some locations are small streams (relatively easy to get depth via manual measurements) while other locations are on the 7th order main stem (much harder to get depth). In addition, some literature estimates of ER_{wc} are in volumetric units and no depth data are provided; the only way to do a direct comparison across all literature rates is via volumetric units. Nonetheless, we acknowledge the importance of considering water column depth for understanding variation in the contribution of water column processes to whole system respiration (i.e.,

ER_{tot}). To address this in the revised manuscript we plan to clarify why we used volumetric rates and also add some discussion on the value of also considering water column depth, per the reviewer's comments.

The authors state in line 395 that "Nitrogen is a key nutrient for microbial growth and is often a limiting nutrient in freshwater rivers (Carroll, 2022)." Another common limiting factor is phosphorus. The authors use a variety of water and catchment parameters to perform the regression. However, phosphorus was not examined. Is there a reason for this? Is this not a potential important factor for ecosystem metabolism in the Yakima River Basin? Including this factor could improve the significance of the regression and significantly influence the conclusion that 40% can be predicted.

We agree that phosphorus is often limiting and probably is important in the Yakima River Basin. Our analysis of phosphorus showed values below detection for more than two-thirds of samples, which is further evidence that it probably is limiting. Because of the analytical limitations, we feel there isn't enough good phosphorus data to include in the analyses. This is unfortunate of course. To address this in the revised manuscript we plan to acknowledge that phosphorus is likely a key nutrient and that while we attempted to measure it, we didn't get data of sufficient quality to include them in the analysis. We will also point out that if we had those data, they would likely explain further variation in ERwc, and we will provide encouragement for future studies to include phosphorus in ERwc studies.

Minor comments:

Line 30: "...which explained 40% of ERwc variability across the basin." You could add here the method you used to come to this number as you use LASSO regression, which has certain assumptions.

LASSO does not natively provide an R-squared estimate, but it does allow for predicting values of the response variable based on values of the explanatory variables. This, in turn, allows estimation of the residual sum of squares (RSS). The total sum of squares (TSS) does not depend on the regression model or predictions and can be directly estimated. We estimated R-squared for each of the 100 LASSO models as 1 - RSS/TSS, as traditionally done with standard multiple regression. We emphasize that we did not use the resulting R-squared estimates as part of the model estimation process, but rather as a way to estimate how much variation in ERwc was explained by each of the 100 LASSO models. We also computed mean and standard deviation of the R-squared values across the 100 LASSO models. In the revised manuscript we will provide a summary of these points to clarify our approach.

Line 216: Reference missing

We will include the reference in the revised manuscript.

Line 390: Could not find Ochs et al. 2010 in the reference list

We will make sure this reference is included in the revised manuscript's reference list.