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Interactive comment on "Diel patterns in nitrate concentration suggest importance of microbial pathways for in-stream processing" *by* Jan Greiwe et al.

Anonymous Referee #2

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Review of "Diel patterns in nitrate concentration suggest importance of microbial"

Summary

Greiwe et al. collected diel nitrate data from three locations in a stream over multiple months to determine the controls of diel nitrate signals. They used cross correlation to show that diel signals were controlled by local in-stream processes rather than from upstream. Next, they used cluster analyses to identify consistent patterns in the diel signals. This is a novel and interesting approach. Finally, they relate the clusters with light and discharge to tease apart what is controlling each cluster.

I think this is an interesting and worthwhile paper. I particularly like the use of clus-

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Discussion paper

ter analyses on the diel data to identify common trends in the diel cycle. However, I believe major revisions are necessary before publication. The biggest issue I have is the attempt to explain diel patterns based on unmeasured microbial processes. This is especially complicated given that many of these processes can cancel each other out (e.g., nitrification and denitrification) and we do not have easily measured proxies (like we have light for photosynthesis). Thus, I suggest that the authors tone down much of the speculation about microbial pathways, and instead focus on what they can show with data.

I also have some concerns with the methods. The cross-correlation approach could be described in more detail. Most importantly, there should be more detail about how the cluster analysis was performed. I am not an expert on cluster analyses and found it confusing how diel curves with multiple data points were put into a cluster analysis. As I mentioned above, I really liked this novel approach and I think it could be used for other constituents (DO, CO2, etc.). A better description of the methods would make it easier for others to replicate the analysis.

Title: I would remove the reference to microbial pathways. This paper has no data to back up the suggested trends in microbial processes.

Line 15: What is plug-flow?

Line 25: A key part of the spiral is that the nutrients are then mineralized to the water column to be taken up again downstream. This should be added here.

Line 31: Can you better describe the link between climate change and nutrient retention? What role does drought play?

Line 46: Denitrification is a heterotrophic process. This line implies that denit could occur via autotrophic processes. Please revise.

Line 93: Please provide more information about the periodical movement of the sensors. Were the sensors moved at equal intervals? Is the data available from each

sub-reach stratified across the sample period?

Lines 106-108: Could you provide more info on interpreting the cross-correlation data? What does a low and high correlation mean? How does this help better elucidate N transported from upstream vs. from in stream processes? A few lines here will help the reader going forward, especially to understand figure 2.

Line 110: What travel time distribution is this referring to? You only conducted one tracer release (I think).

Line 120: I believe that residual should be added earlier in the sentence. ". . .was done on the residuals of the diel solute concentration signal."

Lines 115-127: I am having troubles understanding how the clusters were determined, or in other words, how the k-means approach turned diel data into clusters. Could that be described more? I am used to clusters being used with single values (i.e., animal abundance data), so how can multiple points be used (i.e., from a diel curve). I do not have much experience with clustering, but that will be true for many readers as well. More detail would be helpful.

Line 160/Figure 2: This took some time to determine what I am looking at. Is the main point that points with a high cross-correlation are typically between 0 and the nominal travel time (the shaded area)? Either way I would add a line or two describing the main result out of this figure. Also, how is it possible that a travel time is negative?

Line 175/Figure 3: Do the shaded areas represent a confidence interval? And what calculations were used to calculate the shaded area?

Line 200/Figure 5: Would it be logical to make the y-axis a proportion? The ups and downs are distracting. Making them a proportion would better show the seasonal trends.

Line 201: Something is missing here. Maybe, "Relation of nitrate clusters and reach balance"

Line 220: Please define or further explain short-circuiting.

Line 223: “stated”? Maybe observed?

Line 226: This explanation of the Hensley and Cohen paper is confusing and hard to follow. Could you describe the point of the paper without getting into the details?

Line 240: I don’t believe the description of clusters E and F being influenced by discharge is in the results section. How did you come to this conclusion?

Line 260: What is the relevance of the 0.5 mg/L SRP? What does this threshold indicate?

Line 287: This is also true for estimates of stream metabolism.

Line 247-300: There is a lot of speculation on the drivers of diel patterns in here. It would be much more convincing to use a statistical analyses/models to make conclusions about what is controlling the diel trends rather than relying on the literature and instinct. The correlations with light are somewhat compelling for the first two clusters but it is still hard to disentangle the different microbial pathways relative to the autotrophic. For the other clusters it gets much more complicated and interpretation is pure speculation. That being said, I still think these data are useful and novel. But tying each cluster to a specific driver is for another paper in my opinion. I suggest that this part of the discussion be substantially shortened. I like how you first describe the strong evidence that in-stream, not upstream, processes are driving diel trends. Then go through the clusters or sets of clusters and do some light speculation on the drivers of the signals in relation to the literature. This is done quite well in lines 303-331.

Line 353: Is there a citation for these data?

Line 355: The topic of groundwater should be introduced and described much earlier in the methods section. Also, please address how groundwater might affect the diel curves? Groundwater is likely an important factor for diel curves during summer low flows.

Line 371: We know this already–In my opinion, this is not the strength of this paper. I would end here with a line noting how you were able to separate diel trends in NO3 concentrations into clear clusters with distinct diel patterns and probably different drivers. These clusters can be used a blueprint for future efforts to model drivers of N cycling. Likewise, using the cluster analyses on diel data is a novel approach and could be used for other measurements (e.g., DO, CO2, SRP, etc).

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