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Interactive comment on "Complex interactions of in-stream DOM and nutrient spiralling unravelled by Bayesian regression analysis" *by* Matthias Pucher et al.

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General comment:

We thank the reviewer for their comments on the manuscript. From the comments, we see a need for text improvements and a shift in focus on the biogeochemical processes. Methodological descriptions will be properly described, linked to biogeochemical processes and our motivation and decisions will be explained accordingly. Details on INSBIRE that is only necessary for applications in other studies will be placed in the supplement material to allow a fluent reading for people interested in our findings on the carbon cycle in aquatic ecosystems.

However, we disagree with the reviewers comment that the used INSBIRE approach is done by "turning buttons to fit data without clear ideas about the processes behind". Quite on the contrary, all model assumptions are based on ecological models and processes, commonly known in aquatic biogeochemistry and observed in various other (nutrient) uptake studies, such as saturation uptake kinetics, nutrient spiralling, the nutrient efficiency loss model, hydrological retention, and uptake and transformation processes. We will describe these aspects more specifically.

The parametrization of the model is based on previous studies (mostly the nutrient spiralling concept, additionally the studies by Dodds and O'Brien, both were citet in many other studies). For nutrient addition studies these have proven suitable. INSBIRE extends these concepts from single to multiple compounds which needs to be proven useful, but can be one logical and justified next step from recent research. We explained the extension by the parameter I in lines 241 to 243 because we have not found something comparable in any other study. The initial introduction of I was solely motivated by knowledge about the processes and tested statistically in the following steps. We consider the Bayes factor a suitable metric in model selection to avoid over-parametrization and provided references to support this assumption.

INSBIRE quantifies relations in uptake processes by means of Bayesian posterior distributions but not by means of single values. This approach has proven beneficial in many ecological studies and is justified in lines 203-204 and 514-515. We will make sure, this idea is addressed earlier and more understandable in the manuscript.

We see difficulties in the interpretation because of the novelty of the approach and its application in only one study so far but our study (e.g figure 7) shows a clear picture of the trends in the data. Therefore mainly comparisons and understanding of the drivers are lacking so far. We plan to and see lots of potential to use INSBIRE on many other field and lab experiments where we measure concentrations at different times in the future to add to our understanding of the carbon cycle in aquatic ecosystems.

Introduction

The study aimed at analysing the in-stream uptake of different complex DOM sources and the relation of DOM uptake on the occurrence of and the interactions between different DOM fractions (including co-leached nutrients). The aim was not to study the interaction between nutrients and DOM uptake; thus, no nutrients were added, but some were naturally still contained in the organic matter leachates (albeit at generally low concentrations) and therefore also included in the analyses as parts of the DOM (similar to the organic DOM components). Thus, citing the studies about nutrient-DOC interactions on DOM uptake would, thus, give a completely wrong picture of the actual aim of our study. However, we will rephrase the introduction, clarify the aim, and especially point out the role of the nutrients as inorganic part of the DOM leachate to avoid confusion. We will also include the mentioned studies (and others) in the discussion to interpret interactions between the DOM uptake and the co-leached nutrients; unfortunately, studies in lake systems or lab incubations (Guillemette and el Giorgio, Vonk et al, and many others) or using artificial substrates such as acetate (Catalan et al) are only limited applicable for our study;

We want to stress that DOM addition studies, which look into the uptake and the interactions of the individual inorganic and organic components of the DOM, are scarce and the interpretations are complicated, which makes our study and the developed INSBIRE approach an important step towards unraveling the mechanisms of DOM bioavailability.

We will focus on usability and differences to existing models in the introduction and shift the technical details to the methods or supplement material.

Line 45-47: We will correct this

Line 48: We will add references

Line 60: We will add references

Line 62-63: We will rephrase this sentence. We wanted to stress that mass balance approaches work well with P and N, but are limited if dealing with C components. We do not claim to identify transformation pathways, although they would provide a much more detailed insight into DOM uptake, as the method of spectroscopic analyses is not suited.

Methods

Line 94: We will add mean water residence times for the stretches.

Line 113: We will add this information to the manuscript.

Line 138: Indeed, some additions were quite low mainly due to our attempt to keep peaks within a realistic range, methodological issues (restricted leaching from some sources, low pumping rate), and small environmental changes in background concentrations and discharge. We corrected plateau concentrations by background and removed measurements that deviated from the ambient concentration less then two times the measurement accuracy of our lab instruments to remove questionable values.

Line 149: We will add this information. The number of EEMs was 176 and their origin was the very stream, the experiment took place.

Line 181: We will add the following information: We removed measurements which deviated from the ambient concentration less then two times the measurement accuracy of our lab instruments. The power function was chosen after testing several functions found in various nutrient addition studies (power function, linear function, Michaelis-Menten type function, exponential function and asymptotic regression function) and calculating the Bayes factor of the models. In most of the cases, the power function showed the best fit. Besides, the power function has only one parameter and is therefore less prone to over-fitting. This fact and the better comparability amongst the relations was the reason to use the power function throughout the study. We are aware, that the power function does not provide an upper limit of the uptake, which would be ecologically sound. However, as the power function has been described and used in various other uptake studies, where saturation was not reached, we consider this a valid decision. The wetted width (as all other influencing factors) was added in cases, where the Bayes factor supported this decision. From a detectable influence of the wetted width, we concluded its importance for the respective processes. More wetted width means more surface covered with sediments and benthic microbes and we therefore think there is an important connection. The presented difference in impact of the wetted width is for us a clear hint, that some uptake processes might primarily take place at the sediment surface and others in the water column. However, we have realized from the two reviews that we need to better define and distinguish between the terms of mathematical interaction/correlations, influencing factors, and ecological interaction in the revised manuscript. Errors from the model are presented in figure S01.

Lines 197-199: The use and choice of prior distributions is an important and basic part of Bayesian statistics. We consider this explanation not within the scope of this study. We will add a reference.

Lines 259-260: In regression models of concentration data, it is common amongst statisticians to use lognormal error distributions as a first choice. Therefore it was our first choice as well, but our data did not fit this assumption and we used a normal error distribution instead. We mentioned this because we thought the question might arise. Exemplary studies, although from other geochemical fields of study: Ott (1990) A Physical Explanation of the Lognormality of Pollutant Concentrations, doi: 10.1080/10473289.1990.10466789, Ahrens (1954) The lognormal distribution of the elements (A fundamental law of geochemistry and its subsidiary), doi: 10.1016/0016-7037(54)90040-X.

Results & Discussion

Lines 306-307: We will add statistical information at that point.

Figure 4: We will improve the description and the readability of the graph. We ensured a lateral in-stream mixing at point 1 by measuring a uniform conductivity at several points in a cross section. Figure 4 shows indeed a decline of substances due to reactions. The graph can be changed to show the data corrected for dilution but would still show the same pattern. We will improve the readability of table 5.

Line 501 & 517: We will rephrase the statements. We only want to highlight the novelty and the potential of the approach as well as its limitations to enourage others to elaborate it, test and extend its applicability. We also wanted to highlight that the approach is versatile and based on well studied principles combined in a novel way.

References

References will be considered and added at the appropriate points.

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