Reviewer (R#1) comments and author responses to ms bg-2019-486

Reviewer comments are given in normal style and with author responses in *italic*

Headwater streams are known hotspots for CO2 emissions, although studies of headwater streams draining agricultural catchments, and specially studies that includes a temporal dimension, are sparse. In this study, a headwater stream draining an agricultural catchment was continuously monitored during for approximately one year, and the responses in CO2 concentrations to hydrological variations were studied.

General comments

This study provides important insights of CO2 and discharge dynamics in a headwater stream draining a catchment impacted by agriculture. We need more studies like this in order to better understand the exchange of greenhouse gases between inland waters and the atmosphere. Overall, I think the manuscript is very good. The study is well designed and presented in a well-structured way. I have only a few, although important, remarks that I think would improve the manuscript.

Response: We thank reviewer #1 for their overall positive evaluation of our manuscript and appreciate that it is found "very good" and "well designed and presented in a well-structured way". We believe that the revised manuscript has been significantly improved following the comments given by reviewer #1.

Firstly, this paper would benefit from the authors emphasizing the relevance of their study better. For instance, this study points out potential effects of stream intermittency for streams draining agricultural catchments. This finding is highly important with respect to climate change. Despite this, the authors do no mention this neither in the abstract nor in the conclusions of the paper.

Response: We agree that this is an important finding that we do not well enough lift up as one of the main messages. We do not have enough years of measurements for saying how common the intermittency of this specific stream is. The spring and summer of 2018 was unusually dry, but this kind of conditions are expected to occur more frequently in the future. We have in the revised version included this finding in the abstract and also more explicitly in the conclusions of the study.

Secondly, the manuscript would benefit from a more extensive discussion, for example how this stream compares to other agricultural influenced streams, if the type or insensitivity of the agriculture matters, land use change etc.

Response: We have in the revised version tried to improve the discussion on the spatial representativeness of our findings and also included references concerning DOC-discharge responses in agricultural areas.

Lastly, the readability of the manuscript could be greatly improved by simple sentence adjustments, such as shortening sentences and inserting more commas. Also, the figures could be designed in a more intuitive way.

Response: We have in the revised version tried to improve the readability of the text where appropriate, and we agree that some of the figures needed a quality lift up, although no suggestions on how were given by the reviewer. We have improved the quality of the figures

(mostly improved font sizes) and believe that they are now clear and informative for the reader.

Specific comments

Abstract

L15: It is unclear what "one year of open-water season" means. It would be helpful to add the dates and/or number of monitored days.

Response: We agree that this was a bit unclear, in the revised version we have removed "open-water season" and also added "(in total 339 days excluding periods of ice and snow cover)" at the end of the sentence.

L22: I recommend the authors to add a sentence about the effects of indeterminacy of streams draining agricultural catchments here, since this is an important finding of the paper.

Response: We agree that this was missing. In the revised version we have added two sentences on this topic in the abstract.

Introduction

L41-42: This sentence is unclear. What do you mean with positive and negative responses? Please clarify.

Response: We mean that variations in stream CO_2 concentration have been found to be both positively and negatively related to variations in stream discharge, i.e. either that CO_2 concentrations increase when discharge does, or that CO_2 concentrations decrease when discharge increase (dilution). This is now clarified.

L44: "...dominant CO_2 source areas of catchment soils"? Please rephrase this sentence.

Response: This is now clarified.

L45: Please specify what kind of other catchments.

Response: There is no consensus (partly due to few existing studies) in which catchments CO_2 are mainly controlled by hydrology or biology so it is hard to specify them more than catchments where the hydrological influence is low or non-existing. Hence, we keep the original formulation.

L48: New paragraph needed.

Response: Now added

L50: Please specify what "relevant" time-scales are.

Response: "(<hourly resolution)" is now added.

L69: Please specify what you mean with high-resolution. Also, as mentioned before, it is unclear what "one year of open-water season" actually means.

Response: Both "(hourly)" and "(in total 339 days excluding periods of ice and snow cover)" are now added to this sentence.

Methods

L76: Please rephrase this sentence. Is it unclear if you mean the annual mean temperature or the January and July temperatures. This is especially important since you do not mention the precipitation in January or July - perhaps this could be added.

Response: This is now clarified.

L82: Stream pH ranging between 7.4 and 8.4. Also, this sentence would be much more readable if you would add a comma. In general, I would recommend using commas more frequently.

Response: This is now clarified.

L83-84: How much lower? Please provide a reference percentage.

Response: It is hard to give exact percentages as the variables included in "nutrients" are many. We have instead added, as a general approximation, that the studied stream is within the 25ᵗʰ percentile of the monitored agricultural streams in Sweden when it comes to DOC and nutrient levels.

L86-87: This sentence could be moved to the beginning of the paragraph.

Response: We agree and in the revised version have moved it to the start of the paragraph in ln??.

L90: influences

Response: Correct, now changed

L91: Table S1; Figure S2

Response: Correct, now changed

L93: Would it be possible to add here the percentage that were snow/ice-free (and included in your study) as well as the percentage when the stream was falling dry?

Response: We have again added the total number of measurement days. Concerning the number of days of the dry periods, this is more of a result and is already given in the text.

L100: This is quite confusing for the reader, especially since you have not mentioned before that the stream is falling dry during some periods of the year. In general, I would recommend you to highlight the stream intermittency better, including adding some sentences in the introduction about this.

Response: Again, the dry periods are here seen as result rather than description the methods. Still we needed to explain that analysis of the CO2 data was only made when runoff was generated. It would therefore not be logical to introduce the stream intermittency already in the introduction as this was not included in the aims of the study. However, as it became evident during the study that stream intermittency occurred and also was highly influential for the CO2 dynamics of the studied stream, this is something that needs to be discussed in a more extended way. See response to the first general comment.

L108-109: Please clarify. What is the temporal resolution of your data?

Response: As for many sensor-based systems averaging high-frequency data reduces the noise of the measurements and makes them more reliable. The given averaging time needs to account for relevant time-scales for the processes you want to study but also consider practical limitations as power consumption, data storage etc. In this case we measured at a 1 min interval and stored average values based on these 1 min measurements every 30 min (in 2017) or 60 min (in 2018). This is now clarified.

L112-114: Please rephrase. Also, how many replicates?

Response: We have clarified that one sample was taken at each sampling occasion in ln ??.

L117: Please clarify. When was the phosphoric acid added?

Response: The phosphoric acid was pre-injected in the vial before the sample was injected. This is already stated and so no change has been made.

L121: Did you run any standards?

Response: Yes, certified standards were analysed. This is needed as the DIC-values are given in relation to the PDB standard. This is clarified.

L129: Add reference to Figure S2 here.

Response: Correct, that is now added.

L140: It would probably be easier to follow if you move this paragraph to the beginning of the methods section.

Response: It is not clear how that this would clarify the text and make the methods more logical to follow. We prefer to keep this section where it is.

L145: Another example of a sentence where the overall readability could be greatly improved if more commas are added.

Response: We agree, and a comma has been added.

Results

L155: This sentence is confusing. Precipitation is usually in mm/year however the period is for a bit more than a year. I assume that the "total precipitation" represent the precipitation for the whole period. Thus, it would be easier to read if the sentence would first state the mean air temperature (XXX) and then the total precipitation (XXX).

Response: We write that "The mean air temperature and total precipitation for the entire period (Sep 26, 2017-Dec 12, 2018)". We believe this is already clear and have not made any changes.

L205: It would be good to also add the corresponding pCO2 here for reference.

Response: We have chosen to present the CO2 data as a concentration in the unit of mg C/L as this normalizes for solubility and makes it directly comparable with for example DOC/TOC concentrations if total aquatic C export would be of interest. We give corresponding pCO2 values in ln ?? as an example for how they compare. But we don't think

it is reasonable to give pCO2 values to all given CO2 concentrations in the manuscript while no addition has been made.

L212: Same as above, the corresponding pCO2 values would be helpful as reference values.

Response: Same as above

Discussion

L231: "highly dynamic pattern in streamwater CO2 concentration".

Response: Yes, we have added "concentration" for clarity.

L250: Please add references.

Response: Two suitable references for this statement are added.

L256: could

Response: We agree, is now changed

L258-260: Please rephrase.

Response: We have removed one piece of this sentence that might have been unclear.

L266-270: Great paragraph. Would it be possible to develop more on this?

Response: We have extended this paragraph to further develop the discussion about similarities/dissimilarities in carbon dynamics observed for agricultural streams.

L271-272: Please rephrase.

Response: The sentence is now rephrased in order to clarify.

L309-311: Another great paragraph. This could also be further developed and better highlighted.

Response: We thank the reviewer for this positive comment. We have in the revised version developed this section further and also highlighted this finding in the abstract and the conclusions.

Tables

Table 1: Throughout the manuscript, you write either "land-use" or "land use". In the table it is obviously a spelling mistake; however, please be consistent with the terminology throughout the whole manuscript.

Response: Thank you for noting, we have now used a consistent spelling "land use" throughout the ms.

Table 2: Would be good to add the name of the catchment and not only the abbreviation.

Response: The name is now fully spelled out.

Figures

Figures: I recommend the authors to redo all figures. They are not intuitively designed or appealing for the reader.

Response: Although the comment is very un-specific concerning what to improve, we agree that some of the figures needed polishing, especially concerning font sizes etc. We have updated many of the figures in order to make them easier to read.

Figure 7: Add regression line?

Response: Here we have used Spearman's Rank (which assumes a monotonic, non-linear, relationship), not regression, so fitting a line would not be appropriate. The given statistics in the figure refer to the Spearman rank test.

Figure 10: In the text it is written that d13C-DIC was NOT a function of Q?

Response: Yes, we write "Although there was a tendency towards more negative δ^{13}C-DIC values at higher discharge, no significant relationship was found (Figure 10)". Although not significant from a statistical point of view, we still think it is useful information provided by the figure. One can imagine that the relationship might have been significant if the number of observations would have been more.