

## ***Interactive comment on “Characterizing organic matter composition in small Low and High Arctic catchments using terrestrial colored dissolved organic matter (cDOM)” by Caroline Coch et al.***

### **Anonymous Referee #1**

Received and published: 7 February 2019

The manuscript, “Characterizing organic matter composition in small Low and High Arctic catchments using terrestrial colored dissolved organic matter (cDOM),” presents a good body of work collected in vastly different Arctic catchments. The original data is strong and is mostly presented in a well-structured manner. Comparisons between the two sample locations show very different patterns with vegetation, latitude, rainfall events, and permafrost disturbance. Where the work requires attention is in the language used, sentence structure, some figure reorganizations/enhancements, and section reorganization. Following the major and minor revision suggestions below will greatly strengthen the manuscript.

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Scientific significance: Does the manuscript represent a substantial contribution to scientific progress within the scope of Biogeosciences (substantial new concepts, ideas, methods, or data)? EXCELLENT

Scientific quality: Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)? BETWEEN GOOD AND FAIR The scientific approach and applied methods are valid – GOOD. The results are not discussed in a very balanced way – FAIR

Presentation quality: Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)? GOOD AND FAIR See comments regarding strong language, reevaluation, and reorganization that will improve the results and discussion sections, and the conclusion section should be reevaluated upon the completion of the rest of the edited sections. The number of Figures should be reevaluated based on the restructuring of the discussion section.

Major revisions points include: Adjusting weak language to strong scientific language. Examples are provided in the Line by Line revision points. The introduction is written well, but the results and discussion sections are written in a different style, with a narrative tone, that reads a bit too casually. Narrative writing styles are being encouraged in a great many manuscripts as long as the main messages of each sentence, section, and manuscript aren't lost. The recommendation under this point is to adjust the sentence structure to improve clarity, remove redundancy, and provide stronger scientific language. Briefly, language such as "There was, there are, we saw an initial drop in values. . ." should be replaced with less wordy narrative components where stating what was observed can lead to more clearer understanding. See comments below.

Some figures require extra attention to improve readability and understanding. Those comments can be found below the main text comments. Some figures are included

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and not very well discussed in the text. Check through your figure list, decide which are very important for this work (including the possibility of moving figure S2 into the main text), and write appropriately about them. Figures that are included with little to no discussion should be deleted or moved to the supplemental section. Colors/symbols on most figures need to be improved (detailed comments below). Also Figures and Tables require all terms to be defined in the captions to avoid confusion. All acronyms and abbreviations should be written out as standalone text in the manuscript.

Some results regarding understanding the composition of DOM from SUVA, etc. are written inconsistently. Please re-read the results and discussion section to make sure this information is accurate and not just typos. Also, the flow of the discussion section will benefit from reorganizing the sections. Some important sections are listed last with figures as well, which doesn't strengthen the work. Think about the main message of the manuscript, adjust the title and flow of ideas throughout the manuscript to match the main message. Important points should be made up front (earlier in the discussion section) and even within paragraphs, not at the end. Consider making the important points first in the text, and then support the findings or contrast the findings with the literature information afterward.

Title What is terrestrial colored dissolved organic matter? Using the word terrestrial in the title is misleading. Consider a revision that highlights the strength of the conclusions. Rainfall events? Permafrost disturbances? Suggestion: Comparisons of chromophoric dissolved organic matter composition in small low and high Arctic catchments OR Comparisons of cDOM composition with permafrost disturbance in small low and high Arctic catchments

Line by Line revision points (major and minor included). The comments are organized by sections of the manuscript, including Figures, Tables, and Supplemental material. Page numbers and Line number are provided.

Note: Check the manuscript for fluctuating usage of colored and coloured.

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Abstract Line 20 Please define SOCC

Line 28-29 How are permafrost-derived DOM vs fresh derived DOM being defined in this study?

Line 30 What does fresher DOM prone to degradation mean? Photo? Microbial? Combination? The abstract does not describe the composition of the DOM. Stronger color of DOM does not describe more aromatic and/or lignin-type constituents. What are the absorption results besides “things change downstream”? Consider a more specific details.

Line 31 “This work shows that optical properties of DOM will be a useful tool for understanding DOM sources and quality at a pan-Arctic scale” Yes, the work does, but the abstract doesn’t. Consider blending the ideas together so that the abstract matches the measurements made, chemical interpretations, and conclusions from the work.

Introduction The introduction is nicely written and sets the stage very well. Consider a stronger ending so that it will tie in well with the discussion points and the relevance of small watershed importance with global carbon budgets and vulnerable environments with climate change.

Page 2 Line 21 Typo CDOM instead of cDOM. Please check.

Page 2 Line 25 What is cDOM-DOC? Concentration?

Page 3 Line 6-7 This sentence could be improved by describing the importance of this contribution to global carbon budgets as the climate warms. Consider ending with a stronger contribution statement.

Study Area Page 3 Line 15 Add SOCC here.

Methods Page 5 Line 28 Typo CDOM instead of cDOM. Please check.

Results Page 6 Line 23 Consider revising the subheading to DOC concentration and cDOM absorption characteristics. Usually with a heading that lists specific items, they

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then appear in that order in the text. Think about this heading and whether it makes more sense to report DOC concentration before the absorbance data.

Page 6 Line 23, 24, and 27 Typo CDOM instead of cDOM. Please check.

Page 6 Line 27 Will CDOM slope or spectral slope be used? Also, the spectral slope of both are within the same boundaries if accounting for the standard deviation. Will this similarity be discussed? The sentence as currently written suggests that they are significantly different. Please clarify.

Page 7 Line 2 Revise the sentence to list concentration at the beginning of the sentence for improved sentence structure. Then that word can be deleted in the next line.

Page 7 Line 3 It appears as though the lowercase L and the number one are very near identical or identical looking to read. Consider using a capital L for Liters.

Page 7 Line 5 Consider using the word significantly in this results section when a significance value has been calculated. In this sentence it makes sense and it also makes sense in Line 1, however, this word is used in every sentence thus far on this page. Edit the results section accordingly to use the word significantly or significant when it is appropriate. Also, in this line, an open parenthesis is missing.

Page 7 Line 9 refers to different slopes in Figure 3c. Might adding the slope line/trend line or some kind of calculated slope help readers visualize this difference? This relationship is not clear from the data in Figure 3c with overlapping flowing water and standing water symbols. The overlapping data is at low DOC concentration and low absorbance at 350nm. When those values are increased, there may be a change in the grouping. Can that be reported and highlighted in the figure more clearly? Consider a reevaluation of the data and how those results will be reported.

Page 7 Line 13-14 This information is already reported in the first paragraph and commented on above.

Page 7 Line 14-15 Consider reporting in the text that this is a negative relationship.

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Page 7 Line 16 We jumped from Figure 3c to Figure 4b. Please correct.

Page 7 Line 16-17 Redundant sentence, please delete. What outliers?

Page 7 Line 21 Same comment as the subheading for 4.2 Consider inserting the word concentration after DOC and a descriptive term for the cDOM measurement reported. This also comes up in Section 4.4 and the reason why it's misleading is because the DOC measurement is a quantitative value and the cDOM measurement involves both qualitative information and some quantitative normalization. Is the usage of cDOM all the time in these headings the best idea? What about using DOM and then describing the quantitative and qualitative information below? For example, 4.3 DOM patterns along longitudinal transects AND 4.4 DOM temporal trends with rainfall

Page 7 Line 23-24 This information seems to be in correct based on the figure for both the characterization of DOC concentration in Ice Creek East and West.

Page 7 Line 26-27 The usage of the word “low” in this sentence is misleading. Please describe the data more accurately. Yes, it is lower than Herschel Island, which is what it is assumed to be compared to, but the wording is weak. Describe the trends of the DOC concentration in Cape Bounty first, then make comparisons. Plenty of streams and rivers have DOC concentrations below 1 mg/L, so think about specific word usage when reporting the results.

Page 7 Line 27 Consider this revision to improve clarity, “. . .levels of DOC concentration compared to other Cape Bounty rivers. . .” Also, this is the same trend as the other West River DOC concentration data (without the rainfall event) and that is important to note.

Page 7 Line 28-29 How is that information supported from the figure shown? It looks like three data points are right on top of each other, which suggests they are not longitudinally or hydrologically separated. This information should be clarified.

Page 7 Line 30 No clear pattern was detected in Boundary River? The figure shows two data points here which suggests that a pattern would be tough to determine. Perhaps

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report the similarities between concentrations of Boundary River and Robin Creek?

Page 8 Line 1 Good – we should hope so given the positive relationship. Consider strengthening this sentence by noting the strong relationship between these two parameters. For example, “This confirms the strong positive relationship between both parameters.”

Page 8 Line 2-3 Same comment regarding the usage of the word low. Describe the data as remaining constant or with very little variation. Using the word low assumes a comparison. If the intention is to make a comparison, then describe it clearly.

Page 8 Line 4 Didn't DOC and absorbance also show different trends between these river systems? Consider revising this sentence to flow better with the previous text.

Page 8 Line 4-6 Why isn't the increasing trend at ~1300m reported and discussed for DOC concentration, absorbance, and SUVA in the Herschel Island system?

Page 8 Line 5-6 This is a clear sentence highlighting a comparison between rainfall events. The manuscript can be strengthened by making this point clearer throughout the results and discussion sections with these types of comparisons highlighted on the figures. Use this as a strength moving forward.

Page 8 Line 8 Certainly this could be due to some inputs?

Page 8 Line 9-14 Slope values? Spectral slopes? Or flow gradients? A notation of which figure is being discussed here should be included.

Page 8 Line 16 “Electrical conductivity was found to increase. . .” This is weak scientific writing. Consider using less words to be clearer and strengthen the main message, e.g., “Electrical conductivity increased from. . .”

Page 8 Line 16-18 A notation of which figure is being discussed here should be included.

Page 8 Line 22-24 Please reference the specific part of the figure.

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Page 8 Line 24 The word “drop” is weak scientific language. Consider using “decrease” in this sentence.

Page 8 Line 20-26 This section describes the results organized in Figure 6 a-f, yet the results are written a bit out of order ending with information seen in 6a. Annotate the text with the specific parts of the figure that is being discussed.

Page 8 Line 27 “The hydrochemical response to the following rainfall event (Event-3, 12.7 mm) was different to the previous one.” This is a weak opening sentence. Be more specific to hold the reader’s attention. The response of Event 3 was different than the response of Event 2, correct? State that using stronger scientific language. This type of writing continues on in “Here, we saw an initial drop in. . .”. DOC, absorbance, and Spectral slope decreased after the event, followed by a sharp increase. . . This section is difficult to follow with the events only listed on one part of the figure. Consider marking all a-f figures with a vertical line highlighting the rainfall events.

Page 8 Line 28-29 What does this mean? “SUVA shows an increase with two positive peaks.” All the values are positive, so please describe increases and spikes in the data to higher values using stronger scientific language.

Page 8 Line 30 “No continuous slope records are available for this event as two outliers occurred in this event” This can’t be evaluated without seeing the data or reading about how outliers were determined. Consider showing the data in the SI or discussing how outliers were calculated and extracted.

Discussion Page 9 Line 3 Typo measurement should be measurements. Also, limitations in the measurement itself or the sample? The next sentence discusses precipitates. Clarify the limitation because certainly there are limitations in absorbance measurements to infer biogeochemical relationships.

Page 9 Line 3-5 Redundant language and weak writing. Consider stronger language, for example, “Some samples formed small precipitates, which partly remained in sus-

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pension or accumulated at the bottom of the bottles.”

Page 9 Line 5-6 Consider being more specific with the end of this sentence. Precipitation occurred after filtration during storage, correct? Note the time of storage and any other conditions that are relevant. The way the sentence currently reads assumes immediate precipitation, which probably did not happen.

Page 9 Line 6 “In the absorption spectra, these samples showed extraordinarily high acDOM values. . .” This is redundant. Consider this revision, “These samples had very high absorbance values at 350nm. . .” and consider reporting those values. None of this data can be evaluated so “extraordinarily high” holds no water for the reader. A comparison to the DOC concentration level – what is meant by this? Were the samples settled before running the absorbance measurements? Or were the precipitates blocking, filtering, or absorbing some of the light?

Page 9 Line 6-8 “As described in the methods section (3.1), they were therefore excluded from the study based on the laboratory notes.” This type of writing is redundant and without understanding what the values were before exclusion or any of these laboratory notes, the reader cannot evaluate or confirm any of this information.

Page 9 Line 8 “At Cape Bounty, this was the case for 25 out of 55 samples.” This is very disappointing. Was no redissolution or shaking attempted? This is practically half the data set!

Page 9 Line 13 Meaning absorbance interferences due to the sample and not the method?

Page 9 Line 14 “The cut off between solid and dissolved fraction in a solution is normally made. . .” Use caution here. Dissolved organic matter is operationally defined as material that can pass through a 1.0 $\mu$ m filter poresize. What is listed here is just a few examples of filter poresize used commonly in the DOM aquatic community. Please revise this language.

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Page 9 Line 15 Please add a comma after e.g.

Page 9 Line 18 Please add a reference to this statement.

Page 9 Line 21-22 For what environments? 12% cannot be evaluated without an environmental reference and ties to comparisons of the percentage range or difference in the outlier values.

Page 9 Line 24 There is no filter difference in this study, correct? What is meant with this statement?

Page 9 Line 26-27 “Dissolved iron in terrestrially dominated waters is dominantly complexed with humic and fulvic acids” Wouldn’t this suggest that the “outliers” could also have been influenced by this effect? Was iron measured in this study? Are there any references to iron concentrations in this region?

Page 9 Line 27-28 Did pH and temp change? The reference to Table 2 this late in the manuscript seems a bit out of place. This is good information that should be known before the discussion. Consider moving this table to the results section.

Page 10 Line 5-6 This is the first mention of iron concentrations being measured in this study. Please revise Table 1 or Table 2 to include this important information. Add a methods section describing these measurements. Also, the iron concentration figure in the supplemental (S2) is great and should be added to the main text.

Page 10 Line 9 “Therefore, all problematic samples were removed from this study.” Understandable, but the work would be strengthened if the reader could see all these data and relationships, and then this discussion section would make a lot more sense. This section defines limitations regarding data that isn’t presented.

Page 10 Line 12 Is this a typo? “Our both study sites. . .”? Use Our or Both our to start this sentence.

Page 10 Line 17-20 Is the 195 a typo?

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Page 10 Line 20 Please insert a reference.

Page 11 Line 4 What is a full response of a rainfall event? This sentence is very confusing.

Page 11 Line 6-7 Consider revising this sentence to improve clarity. This indicates a decrease in aromaticity and a shift to lower molecular weight, which suggests. . .

Also, please define what is meant by labile material. Labile from a microbial perspective?

Page 11 Line 8 What is a clear increase?

Page 11 Line 10-11 Confusing sentence. The meaning is meant to be about the rain itself or the river? During the event or after?

Page 11 Line 16 The duration of the rainfall event seems very important. This point should be included earlier in the text, added into a table, or gray shading can indicate the duration in Figure 6.

Page 11 Line 23-24 A tremendous increase? Compared to what?

Page 12 Line 16 Redundant portion of the sentence - delete “across the Arctic”

Page 13 Line 1 “. . .constant proportion of bioavailable DOC. . .” Meaning concentration or qualitative nature? The meaning of DOC is dissolved organic carbon and doesn’t inherently imply concentration so the usage of DOC in this manuscript should be clarified where appropriate and this section of the discussion needs to include more descriptive qualitative or quantitative language.

Page 13 Line 4-6 Example of weak language and very confusing ideas. How was the influence of ice wedge polygons assessed? The information is provided after the confusing sentence. Please reorganize and use concise language.

Page 13 Line 6-7 But not upstream? This sentence does not make sense as written.

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Page 13 Line 8-9 How does this make sense from the previous statements? The flow of this paragraph is very confusing.

Page 13 Line 10-11 Why is rainfall discussed again in this permafrost impact section? Is that the disturbance? Clearer ideas need to be presented.

Page 13 Line 13 “SUVA and S275-295 do not show strong differences downstream in the West River.” This is a result. Why is this? Is this discussed?

Page 13 Line 18 What does a shallow S275-295 mean?

Page 13 Line 20 In this sentence, low aromaticity is linked with SUVA increases, yet a few sentences ago it is linked with decreases in SUVA. This is very confusing. Greater SUVA values mean???

Page 13 Line 20-30 This section was difficult to read and understand the flow of the main discussion points. Please reorganize and put main discussion points up front in the section, then provide supporting evidence throughout the paragraph.

Page 13 Line 31 What is cDOM-DOC? And this section seems really important. Can it be reorganized earlier in the discussion section. If the figures are being kept in this section, then they will appear earlier. A reference to Figure1 might also assist in the terrestrial/nature argument of the different catchments.

Page 13 Line 32-33 This is another example of weak language. Consider this revision to improve scientific language and flow of ideas. “Strong positive correlations between DOC and acDOM350 were previously reported in similar Arctic rivers and globally (insert references).

Page 13-14 Line 1-2. This information stops the flow of the discussion. Consider removing the sentence, keep the references, and reorganize the next sentence to include them.

Page 14 Line 4 “This means that...” is an example of weak language. Consider

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revising these two thoughts into one sentence with a connecting word like “indicating” so that unnecessary words are removed, and the main messages are clear.

Page 14 Line 4-6 Why is the point of stating this?

Page 14 Line 1-6 Is the point of this section to state the good correlation and proxy for DOC concentration using absorbance? Figure inclusion and discussion should be an important component of the manuscript. Why is it important in this work? Think about the distributions of the data and the relationships to the other work. Does the other comparative work have similar geographical features? Ice-wedges? Etc.?

Page 14 Line 7-8 Very confusing sentence. Another example of weak language. Is this referring to concentration and a directional trend?

Page 14 Line 9 Delete “where a large range of absorption values is covered”. This is redundant. Check each sentence for repetition and redundant ideas.

Page 14 Line 11 Going back to Figure 7? Consider keeping Figure 7 discussion in the same section.

Page 14 Line 17 “higher aromaticity, which suggests that the material is fresh and prone to degradation” and fresh material? Fresh from what? Fresh as considered by what? Light? Microbes? Terrestrial soils?

Page 14 Line 18-23 This seems like important information to put in the results section. Then it can be discussed in this section. Consider reorganizing this section.

Page 14 Line 26-27 This point was just made in the discussion section and not fully developed to be included yet in this conclusion section. How are the linkages supported?

Page 14 Line 29-31 These points needs to be clearer in the results and discussion section. Please reorganize.

Page 15 Line 2-3 Redundant sentence. Please delete.

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Page 15 Line 4 Fresher DOM prone to degradation means what? How is fresh defined? What type of degradation?

Page 15 Line 7 This idea needs further development in this work and cannot be a standalone conclusion. The same comment can be applied for the remaining conclusion statements.

Figure 1 In (a) it is a little confusing that ocean and glaciers are white? Is that correct? Where are the glaciers? Consider using line and dotted line symbols in the legend for catchment and subcatchment areas so that readers don't look for boxed regions. Can river flow direction be added to these (b) and (c) figures? The legend is written well and was easy to read. Consider two revisions to include the word "concentration" when referring to DOC measurements and define CAVM in the caption.

Figure 2 Very aesthetically pleasing, well done. In the caption, please revise the opening statement to "Dissolved organic matter (DOM) absorption characteristics from Herschel. . ." so that all the terms are defined.

Figure 3 Great ideas here, just need slight improvements to enhance understanding and readability. Define the terms in the caption, DOM, DOC, ICE, ICW, etc. Next, the symbols of circles and triangles indicating flowing and standing water are good, but too small in all these figures. Also, triangles and circles overlapping each other look like blobs. Consider open and closed symbols to improve readability. The data blobs are hardest to read in (a). The choice of pink and red or purple and pink colors are too close together to visualize clearly in (b) and (c). Consider using light green and dark green (or some similar color tone gradient) for upstream and downstream to keep that data grouped together aesthetically. Add trend lines for (c) to show the different slopes or box/circle the two different groups to help visualize the differences discussed in the text.

Figure 4 Same comments as Figure 3 with caption definitions, data point size, circles and triangles, and color tones. Also, is the variability of Cape Bounty discussed in the

text? These figures should really tight groupings for Herschel but not Cape Bounty.

Figure 5 Similar comments to Figure 3 and 4. Same sites should use colors that fall in the same family with different gradients so they can be linked visually on the figures. Shades of green IC East on different sample dates will help. Keep acronyms similar among figures, e.g., IC East vs. ICE. These figures have a lot of gridlines on them which makes the dotted line hard to follow. Consider removing the gridlines or thickening the dotted lines. Also, consider using different symbols for different river samples. Define the terms in the caption.

Figure 6 The gridlines wash out the green data points and lines. Consider changing the color scheme and increasing the size of the connected lines and data points. Adding a vertical line through all figures for each rain event will improve these figures. Missing data should be notated in the caption. If all the data was collected in 2016, please remove the 2016 date indicator on the x-axis because it is very crowded. The legend also includes IC west and IC East. Please make this consistent with the other notations in the previous figures and define all the terms.

Figure 7 Good figure. If it is needed still in the manuscript, since only two to three sentences discuss parts of it, then keep it with some improvements. Keep the reference on the figure but put the regions for the samples it is referring to in the figure caption and remove these words from the figure (it crowds the data). Define the terms in the figure caption. There are multiple data sets with the same color assigned to them. Please select different colors to see the different groups represented on this figure. Also, consider including the slope calculated from this work as a comparison to the literature calculated slope.

Figure 8 Good figure. If it is needed still in the manuscript, since only two to three sentences discuss parts of it, then keep it with some improvements. Define the terms in the caption. Is it possible to put black outlines around the Permafrost extent legend colors? The isolated patches color is very difficult to read in the legend. Also, mark the

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color of the ocean, since it is nearly identical to the isolated patches color, or change the ocean color to something darker?

Table 1 Define the term CAVM in the caption. Some formatting of this table is confusing like the dark thick line near the top and then a defining line combining ICW, ICE, and CB. Consider using indents for the sample names under the low and high Arctic categories, using another horizontal row divider (as in Table 2), or separate columns.

Table 2 Define the terms in the caption (all abbreviations and acronyms) and provide an explanation for underlining as a useful tool for these statistical comparisons. Typo at the bottom line “He” should read “HE”

Table 3 Define the terms in the caption.

Supplemental Information Define the terms in the figure and table captions. Consider moving S2 to the main manuscript.

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