Interactive comment on "Synchrony in catchment stream colour levels is driven by both local and regional climate" *by* Brian C. Doyle et al.

Anonymous Referee #1

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Reviewing the manuscript entitled "Synchrony in catchment stream colour levels is driven by both local and regional climate" (Doyle et al., submitted to Biogeoscience)

General comments to the authors

The present manuscript analyzes the temporal correlations between climatic and hydrological variables and water color data collected weekly over six years from three blanket peatland catchments in Ireland. Correlations were compared across catchments with different morphological characteristics and across time scales from weeks to years. In addition, inter-annual and seasonal variabilities in dissolved organic carbon (DOC) exports are presented. The correlations were similar in magnitude and direction in all catchments and across all time scales with soil temperature, soil moisture deficit and the NAO index as a key-correlates. Variability in key-correlates and water color

implied variability in DOC exports.

The well-written and well-organized manuscript addresses an important area of research in biogeochemistry / earth system science: how do terrestrial carbon stocks respond to climate change and what is the role of inland waters as a potential export pathway of these stocks? The authors acknowledge the large amount of previous work published on this topic, but in regard to this, should highlight more the knowledge gap and niche that the present manuscript fills. The authors used an interesting approach of cross-wavelet time-series analysis to investigate time scales of magnitudes and directions of correlations. In biogeochemistry, especially peatland biogeochemistry, this analysis is novel and allows new insights in addition to classical correlation analysis. The results and implications of this analysis appear to me a bit drowned among the wealth of other results (which are more straightforward and not very novel, especially in the light of the findings by Ryder et al. 2014). Can the authors highlight the cross-wavelet time-series results more to make a clear stand of how it contributes to new insights? What can we learn from this analysis about the time scales of effects (a good example is given on p. 13, L. 31), what are the problems (as touched upon on p. 15, L. 4-5)?

The two parts of the paper, the analysis of environmental correlates of water color and variability in DOC exports, are interesting in themselves, but what would be even more interesting to many readers was to combine the results of the two analyses: what explains inter-annual and seasonal variability in DOC exports? This is touched upon on p. 16, L. 7-8, but not directly shown. Doesn't the available data allow a more direct analysis of environmental drivers of DOC export (at a seasonal and annual scale)?

The authors highlight both "local" and "regional" climate in the title. To rigorously support this title, wouldn't it be helpful to also explicitly analyze how the regional climate affects the local climate (soil temperature) and to what extent this effect is similar across catchments? If such an analysis would reveal that the regional climate affects local soil temperatures independent of catchment characteristics, it may explain the synchrony

in water color responses to climate across catchments.

To my understanding, there is a mismatch between stated goals, provided analyses and conclusions. In the conclusions, the authors highlight that environmental drivers of water color can differ depending on catchment specific characteristics. However, almost all drivers were the same in magnitude and direction across the different catchments (Fig. 4, and see also p. 10, L. 17-22 and p. 11, L. 13-25). Moreover, the authors only tested for differences in DOC loads (but not drivers) across catchments. This mismatch must be resolved. An analysis of whether drivers differed between catchments would, however, be not very powerful, given that only three catchments were included which, after all were rather similar in key characteristics such as the percentage of streams intersecting peat (Table 1). To strengthen the qualitative discussion of how catchment characteristics modify drivers and magnitudes of DOC loads, it would be valuable to know what range of environmental conditions the studied catchments cover relative to the whole range of Irish blanket peatlands.

Specific comments to the authors

Throughout the manuscript: The authors often use terms such as "controls" and "drivers" (see e.g. p. 2, L. 11). These terms imply mechanistic relationships between environmental drivers and water color. However, the authors used a statistical approach that allows to investigate correlations, not mechanistic links. I suggest to rephrase all terms throughout the manuscript to make clear that relationships were correlative, not mechanistic.

p. 2, L. 1 (Title): Here, the term "climate" is used, but in the abstract (L. 25) the term "meteorological drivers". Please harmonize.

p. 2, L. 4: the term "reservoirs" could be misunderstood, especially by the aquatic biogeochemistry community. Maybe simply use the term "stocks", or "soils" instead of "terrestrial reservoirs"?

p. 2, L. 7-10: This is a very long sentence and hard to digest. I suggest to split it.

p. 2, L. 12: maybe clarify more by adding "in correlations" after "frequencies"?

p. 2, L. 12-14: "Although at 130 mg PtCo L-1, the colour levels in the Srahrevagh (the subcatchment with lower rainfall and higher forest cover) were almost 50% higher than those from the Black and Glenamong, 95 and 84 mg Pt Co L-1 respectively." Why do the authors introduce the sentence with "although"? is it to highlight that the low-rainfall catchment was expected to have clearer water than the other catchments? I would restructure the sentence to get this message better come through.

p. 2, L. 15-16: "illustrating that environmental drivers operated synchronously at each of these temporal scales, and also spatially within the same catchment ": what exactly do the authors want to state here? It reads to me like that environmental drivers were similar across the catchments, but this would contrast to the conclusion that drivers varied depending on catchment-specific characteristics. It would also contrast the statement further down in the abstract (L. 24-25) that "the results of the study highlight the interaction of catchment conditions and regional meteorological drivers". Please clarify.

p. 2, L. 23: why is the term "although" used here? Isn't is enough to simply write that there was inter- annual variation?

p. 2, L. 24: it would be interesting for a wide readership to know whether these inter-annual variations in DOC loads are linked to variability in climate. This remains unclear in the way it is phrased here.

p. 2, L. 24: Can the authors specify what is meant with "interaction of catchment conditions and regional meteorological drivers? what characteristics makes DOC export from a catchment more or less susceptible to environmental drivers? This should be highlighted here, or at least in the conclusions of the manuscript, if supported by the data.

p. 3, L. 3: "warmer and wetter" conditions is relative. Which climate zone is referred to

here?

p. 3, L. 19: what are "year-to-year changes in climate"? climate refers to a period of at least 30 years. I think it is meteorological conditions the authors refer to here.

p. 3. L. 19-25: is an introduction of these enzymatic mechanisms needed? The terms used are quite technical and it seems that it is not relevant for the remainder of the manuscript. I suggest to simply of skip.

p. 3, L. 26: "Canadian lakes have been shown to correlate": what property of these lakes is referred to here?

p. 3, L. 32: which "Ref" is referred to here?

p. 4, L. 25: the authors mention here the implications for future management of peatland systems. Can the authors formulate such implications in the discussion section?

p. 6, L. 11: define "blanket peat" (regarding peat depth) when first mentioned in the manuscript

p. 6, L. 18+20: "gentle" and "steeper" slopes are relative terms. I suggest to refer to absolute numbers here.

p. 6, L. 23: Please add a reference or vendor for the Arcmap program.

p. 6, L. 29: Is it the Newport Met Station that is indicated in Fig. 1? If so, please indicate in the figure and refer to the figure in the text.

p. 6, L. 30: please give the location of the vendor of the water level loggers.

p. 6, L. 31: please report goodness of fit / error measures of the site specific rating curves.

p. 7, L. 6-9: How does this analysis relate to the study aims? Also, I'd appreciate a motivation for the choice of the statistical tests. Was the A Wilcoxon Signed Rank Test used to account for the nestedness of the Black and Srahrevagh rivers?

p. 7, L. 11: please clarify "Loess"

p. 7, L.11: please give a reference for the R program used (move it up from p. 7, L. 29).

p. 7, L. 23- p. 8 L. 19: How were the GAMM models reduced to find the optimum model with three smoothers?

p. 7, L. 25: is the mgcv package an R package? Please indicate. Equation 1: use italics consistently, i.e. even for T_{lt}

p. 8, L. 6: What is the motivation to include wind speed, radiation and humidity in the model? Background / hypotheses for testing these variables are not given in the introduction.

p. 8, L. 12: How did you use NAO in the statistical analysis? As explanatory variables? Please clarify.

p. 8, L. 13: please clarify the abbreviation "SMD"

p. 8, L. 21: what exactly is meant with "to further examine the linkages between each of the explanatory drivers"? I would expect many readers to be unfamiliar with the cross-wavelet transform analysis (including myself) and would appreciate a clarification, in simple words, what the analysis does.

p. 8, L. 27: Please give more details on the Monte Carlo methods used!

p. 8, L. 32: were the residuals of the linear regression between DOC and color homoscedastic?

p. 9, L. 1: add details on the location of the vendor of the DOC analyzer.

p. 9. L 4-5: What is meant with "mean load" and "annual load"? is it the annual mean load referred to here?

p. 9, L. 19: which time period is referred to here? 1995 to ... ?

p. 9, L. 28: is the "top 10%" the 90% percentile?

p. 11, L. 2: what does "edf" stand for?

p. 11, L. 12-25: I very much appreciate the sensitivity analysis, investigating the performance of the GAMM model depending on whether SMD or discharge is included!

p. 11, L. 26-31: How strong was the correlation between NAO, soil temperature and SMD? It comes somehow through in Fig. 5, but some metric describing this correlation might add further valuable context to the relatively low contribution of NAO in addition to the effect of soil temperature and SMD.

p. 13, L. 8: To my understanding, DeFries and Eshleman (2004) only discuss forestry effects on hydrology, not DOC export. Please refer some of the many papers that show increased DOC loads in response to forest clear-felling (e.g. Nieminen 2004, Silva Fennica 38(2); Schelker et al. 2012, GRL). ÂÍ

p. 13, L. 10: how about replacing "goes some way in" by "may help"

p. 13, L. 12: How much is known about the forestry intensity in the catchments? Is the forest clear-cut? In Table 1, only the areal proportion of forest (based on CORINE data) is given, but this does not imply that the forests are managed. Is this the same information that is given in Fig. 1 (symbol code "forestry")? More information on forestry is needed to support the statement that forest clearcutting could explain differences in DOC loads across catchments.

p.13, L. 27-30: Would the interaction with water table fluctuations imply that correlations between soil temperature and water color is low at time scales « 1 year (as apparent from Fig. 6)? If so, I'd suggest to refer to results shown in Fig. 6 here.

p. 14, L. 4: to test this, would it be possible to run the cross-wavelet analysis for time scales longer than 1 year?

p. 15, L. 18: the term "weather" is maybe not optimal here. How about "low pressure

systems" or "cyclones", etc...?

Fig. 1: what do the green-blueish areas mean in the figure? This color code is not explained in the figure legend.

Fig. 1: is the weather station the "Newport" met station? Please indicate.

Fig. 1: please explain the red dot in the map of Ireland.

Fig. 2: explain the abbreviation "SMD" in the figure caption.

Fig. 3: improve the resolution and contrast of the figure

Fig. 3, caption: add "water" in front of "color".

Fig. 3, caption: the letters "B", "C" and "D" appear in the wrong position. Please correct.

Fig. 4, caption: explain the meaning of "s" shown on the y-axis scales.

Fig. 4, caption: explain the abbreviation "SMD"

Fig. 5: I cannot find an explanation in the methods section on how this analysis was done. Please clarify. Details on the trend analysis of water color is given, but not for the environmental driver variables.

Fig. 5: the figure appears stretched along the x-axis in my version. Please modify.

Fig. 5, caption: please indicate the time scale of the trends shown. Is it weekly averages?

Fig. 5, caption: explain the abbreviation "SMD"

Fig. 6: What do the line graphs on top of the contour plots indicate? Also, the tick marks along the axes of these line graphs are hardly visible. Please increase font size and add axis labels.

Fig. 6: Which depth does soil temperature refer to?

Fig. 6, caption: explain the abbreviation "SMD"

Fig. 6, caption: What are edge effects and what is the cone of influence? Please explain here or in the methods section.

Table 1: is the climatological data given here recorded at the Newport met station? Please indicate.

Table 1: "stream length" can differ a lot depending on how / at which spatial resolution it is mapped. how is "stream length" defined? What is the smallest system (e.g. in terms of upslope contributing catchment area) considered here?

Table 2: please explain the abbreviations "edf" and "Ref.df". These values are identical. Why?

Table 3, caption: maybe mention that Lough Feeagh is the lake shown in Fig. 1, or indicate the lake name in Fig. 1?

Table 3: it was not immediately clear to me that the seasonal DOC loads given in the lower part of the table are linked to the years listed in the table header. Maybe explain that in the figure caption?

Table 3: please explain abbreviations D, J, F, ...

Table 3: Shouldn't the sum of the seasonal DOC loads equal the annual DOC loads? This is at least not the case here. Why?

Use consistent abbreviations ("Fig.") for "figure". Some figures are not referred to in the text in the same order as they appear in the figure section. For example, Fig. 3 is referred to before Fig. 2 is referred to.

Typos

p. 2, L. 21: delete one of the "each"

p. 4, L. 10: "trend" should be plural to be consistent with "changes" mentioned before

p. 5, L. 26: delete one of the "spatially"

p. 6, L. 29 replace the first "," by "and", and remove the second ","

p. 7, L. 16: delete one of the "for"

p. 8, L. 23: use "were" instead of "are"

p. 9, L. 1: add a full stop between "rivers" and "doc"

p. 15 , L. 27: remove the full stop between "that" and "both"

Fig. 2: remove "(" after "standardized precipitation index" at the y-axis label of the uppermost panel.

p. 24, L. 4: there is a digit missing in "201"

Table 1 caption: "sub-catchmen" is missing a "t"