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

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Responses to reviewer No 2 comments for Doyle, B. C., de Eyto, E., Dillane, M., Poole, R., McCarthy, V., Ryder, E., and Jennings, E.: Synchrony in catchment stream colour levels is driven by both local and regional climate, Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-272, in review, 2018. Reviewer 2 Comment: Line 5: well, all of this carbon is not transferred to the atmosphere since some of it may be stored in long-term deposits such as lake or ocean sediments. Response: We agree, the sentence now reads. 'Streams draining upland catchments carry large quantities of carbon from terrestrial stocks to downstream freshwater and marine ecosystems. Here it either enters long-term storage in sediments or enters the atmosphere as gaseous carbon through a combination of biotic and abiotic processes.' Comment: Line 10:

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Temporal change in what? Response: We agree that the meaning is not clear, the sentence now reads. 'This six-year data set was collected in three contiguous sub-catchments (the Black, the Glenamong and the Srahrevagh) in a blanket peatland catchment system in western Ireland. The data were used to describe the patterns of change in river water colour over time and to assess the main factors explaining these changes.' Comment: Line 12: I guess unit should be mg Pt Co L-1. Response: The units have been corrected in the manuscript. Comment: Line 12-14: I find this sentence a little odd; I expect something to follow the "Although ...". Ok, so the colour concentration was higher in Srahrevagh, but why "although"? Response: We have rewritten, and the sentence now reads. 'At 130 mg Pt Co L-1, the mean colour levels in the Srahrevagh (the subcatchment with lower rainfall and higher forest cover) were almost 50% higher than those from the Black and the Glenamong, which were 95 and 84 mg Pt Co L-1 respectively.' Comment: Line 17-18: Does these numbers (54% and 58%) refer to 1) soil temperature + soil moisture deficit and 2) NAO or to 1) soil temperature and 2) soil moisture and NAO. There are only two numbers but three variables making this sentence unclear. In the next sentence you refer to the combined effect of three variables; why do you not do that here? Response: We agree that sentence was unclear. We have reworded as follows: 'For both the Black and its nested Srahrevagh catchment, three variables (soil temperature, SMD and the weekly NAO) combined to explain 54% and 58% of the deviance in colour respectively'. Comment: Line 21: remove one "each" Response: This was an error, and the sentence now reads: 'Each relationship, however, varied in phase, further highlighting the complexity of the mechanisms driving river colour in the sub-catchments.' Comment: Line 23: You use different number of digits here. Also, I guess these numbers are per km2. So should it be 15.0 and 14.7 t C km-2 yr-1? And why do you only report load for two of the three catchments? Response: We agree. The sentence now reads, 'The estimated mean annual DOC loads for the Black and Glenamong rivers to Lough Feeagh were 15.0 and 14.7 t C km-2 yr-1 respectively, and the export values displayed significant inter-annual variation that was intimately linked to climate variability.' We reported the load

from the Black and the Glenamong only as these are the two main inflows to Lough Feeagh and therefore these are the two main C loadings to the lake. The Srahrevagh sub-catchment is nested within the Black catchment.

Comment: Line 25: but the analysis you refer to above relate to concentrations. At least in the abstract, you do not mention what controls the C export. Response: We agree with the reviewer that the main focus of the study is the variation of colour concentration and therefore DOC concentration in the catchment streams. We report the calculated C export to give readers an idea of the scale of C transport in the sub-catchments. Comment: Introduction P 3 line 5: What do you mean by "...primary production exceeds ... soil organic matter"? Response: We agree that the meaning was not clear. The sentence now reads. 'Under such conditions, primary production exceeds decomposition of soil organic matter, and therefore soil organic carbon (C) accumulates.' Comment: P 3 line 11-12: I suggest you remove the assumed sources of DOC and POC in the parentheses, partly because the sentence is general in form (for instance, not all DOC comes from peat degradation in many catchments) and partly because I am not aware of studies that clearly identify the primary source(s) of DOC or pathway of DOC formation. Previous studies in the UK have e.g. shown that DOC generally is of recent origin, i.e. post 1950s (see e.g. Evans et al., 2007 or Billett et al., 2007). This does not mean that old peat is N sources (could, however, be young peat!). Also P3 line 12: remove "more" before "dominant" Response: We agree to both comments the sentence now reads. 'In most studies which have evaluated fluvial losses of both dissolved organic carbon and particulate organic carbon, DOC has been identified as the dominant C form, representing between 60% and 88% of the total carbon load.' Comment: P 3 line 12-16: You need to be careful with the terminology here. Do you e.g. mean that 60 and 88% of total carbon load, i.e. including DOC, POC, DIC and PIC, were DOC? Or do you mean that 60-88% of total organic C was DOC? Whereas DOC may dominate in many areas, this is often not true where there are large portions of calcareous bedrock within the catchment. Thus, you need to clarify if you mean total C (i.e. including inorganic C) or total organic C. Response: We agree that this

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sentence is somewhat confusing the sentence refers to organic C only and that the DOC fraction dominates. The sentence now reads. 'In most studies which have evaluated fluvial losses of both dissolved organic carbon and particulate organic carbon, DOC has been identified as the more dominant C form, representing between 60% and 88% of the total organic carbon load.' Comment: P3 line 20: yes, but not only decomposition but temperature will also affect other potential DOC forming processes, e.g. root exudates from primary producers Response: We agree. The sentence now reads. 'At local scales, temperature affects potential DOC forming processes, including peat decomposition rates and root exudates and therefore the availability of DOC, while higher precipitation increases the washout of DOC from soils.' Comment: P 3 line 26: I guess it is the DOC in the lakes that correlate with climate indices, not the lakes themselves, or? Response: We agree the meaning was not clear. The sentence has been corrected and it now reads. 'At regional scales, DOC concentrations have been shown to be influenced by global weather patterns, for example DOC concentrations in certain Canadian lakes were shown to correlate with climate indices such as the Pacific Decadal Oscillation and the Southern Oscillation Index (Zhang et al., 2010).' Comment: P3 line 29: remove the acronym SLP – it is not being used anywhere else in the manuscript and thus superfluous. Response: We agree and it has been removed from manuscript. Comment: P 3 line 32: What should Ref be? Response: It was a typo and it has been removed from manuscript Comment: P4 line 14-16: This was also found by Winterdahl et al. (2014) where TOC was increasing in about half of 130 streams, but without any clear geographical patterns. Also worth mentioning is that some authors claim that DOC concentrations have stopped increasing or are actually decreasing (Worrall et al., 2017) whereas others have pointed to methodological differences among studies that limit interpretations of potential trends (Filella & Rodriguez-Murillo, 2014). And P4 line 16: But the studies referred above did not study DOC export but DOC concentrations. Once again you need to make clear if it is export or concentrations that are the focus of study. The export is to a large extent controlled by water discharge, and thus ultimately by the difference between precipita-

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tion and evapotranspiration. Response: We agree and propose to rewrite as follows. 'There are, however, also studies where DOC concentrations have been shown to have decreased (Clair et al., 2008; Worrall et al., 2017), or no increase has been observed, such as within certain catchments in the U.K. (Worrall and Burt, 2007). Winterdahl et al. (2014) also reported increases in TOC in only half of 130 Swedish streams, but with no clear geographic pattern highlighting the need for further examination of the complex relationship between DOC concentration and climate.' Comment: P4 line 21-22: This sentence seems out of topic – you have not discussed effects of changes in nutrient cycles before and Kurbatova et al. studied Russian bogs which I suspect behave quite differently compared to the blanket peats on the British Islands (in terms of e.g. hydrology and topography). Response: We agree and the sentence has been removed from the manuscript. Comment: P4 line 28-29: Repetition. You have already mentioned that this is one of your study catchments.

Response: We agree, the portion of the sentence has been removed. The sentence now reads. 'For the Glenamong sub-catchment, Ryder et al. (2014) previously reported that soil temperature, river discharge and a dry spring period explained approximately 60% of the deviance in DOC concentrations over a two-year period.' Comment: P4 line 32: change to "...climatic conditions, e.g. the NAO, as a possible..." Response: We agree, and the sentence now reads. 'The present study expands on that work, firstly by comparing colour concentrations from three contiguous peat sub-catchments that differ in their catchment characteristics, and secondly by including the role of the regional climatic conditions, e.g. the NAO, as a possible driver.' Comment: P4-P5 line 33 ff: The aims need clarification. First you mention the Burrishoole catchment but later you write "water colour from rivers in three sub-catchments in a blanket peatland catchment" – why not specify that this is the Burrishoole catchment? Also, part 2 need to be specified; the effects of main climatic drivers on what? Response: We have clarified the aims of the paper. The sentence now reads: 'The principal aims of the current study, using water colour data from the Burrishoole catchment in the west of Ireland were 1, to compare the sub-seasonal, seasonal and multi-annual trends

in water colour 2, to identify the main climatic drivers of water colour variation and 3, to quantify the inter-annual variability in fluvial export of DOC over the study period.' Comment: P5 line 6-8: It would be interesting to know the area of the entire Burrishoole catchment. Response: This information has been added, the sentence now reads. 'The Burrishoole catchment (∼100 km2) is a topographic basin, that has been carved into the Nephin Beg mountain range over successive ice-ages and comprises twenty-one lakes of sizes ranging from 0.04 ha to 395 ha and approximately 143 kilometres of interconnecting rivers and streams (53° 55' N 9° 55' W).' Comment: P5 line 18: You can remove the (Co-ORdinated INformation on the Environment) but write CORINE in capital letters (as you do in the reference list). Response: We agree. The sentence now reads. 'Land cover in the catchment comprises 52% blanket peat, 15% forestry, with the remaining 33% being made up of discrete parcels of transitional woodland and scrub, natural grasslands and agricultural land (CORINE, 2012)' Comment: P5 line 24: why do you report precipitation only for 2010-2016 when you obviously have a longer time series of precipitation from the area? The mean precipitation for 2010-2016 is reported in the results anyway. Response: We agree. We are adding a recently published long term averages from the Newport Meteorological Station. The sentence now reads. 'Long-term average annual precipitation at this station (1960–2014) was 1564 mm. Average daily rainfall for the same period was 4.3 mm (±6.2 mm SD), and 75% of days had some measurable rainfall (de Eyto et al., 2016)' Comment: P5 line 26: you repeat "spatially" here – remove one P5 line 27: Above you did not use a thousand separator (,) but here you do. You need to be consistent and comply with the format of the journal. Response: We agree, one "spatially" was removed and the thousand separator has been removed also. Comment:

P5 lines 26-28: Are these precipitation numbers from the same year? Or are they annual means? That is not clear now. I think you need to show the spatial variability better because as it is now, it is not clear how these observations differ from Newport (besides that the numbers are a bit different). You could perhaps show how large the spatial differences are on average among years (including all three stations with precip.

Response: They are annual means over the study period. We have included standard deviations for the rain gauge data. The sentence has been reworded as follows. 'It is also important to note that spatially, rainfall levels varied spatially across the catchment over the study years from an annual average of 2623 mm year-1 ($\pm$386 mm year-1 SD), recorded at an automatic rain gauge in the northwest of the catchment (Namaroon) to 1508 mm year-1 ($\pm$158 mm year-1 SD) at the south of the catchment (Millrace rain guage) (MI unpublished data).' Comment: P6 line 8: I guess this should be (Figure 1 and Table 1) Response: We have amended the manuscript. Comment: P6 line 16: change to "three sub-catchments" Response: We have amended the manuscript. Comment: P6 line 23: Change to "10 m resolution" Response: We have amended the manuscript. Comment: P6 lines 26-27: What was the precision of this instrument? If you have data on accuracy, that would also be relevant to report here. Response: We have included the accuracy of the instrument; 'Colour (mg PtCO L-1) was measured within hours of sampling using a HACH Dr 2000 spectrophotometer at 455 nm on water filtered through Whatman GF/C filters (pore size: 1.22 μm). Wavelength accuracy = $\pm$2 nm from 400 – 700 nm and $\pm$3nm from 700 – 900 nm.' Comment: P6 line 29: "Daily precipitation and soil temperature data. . ." Response: We have amended the manuscript. Comment: P6 line 30- ff: How was the rating curve calibrated? I.e. what methods were used to construct the rating curve? I also think you should report the accuracy of this rating curve, e.g. with an R2. Response: We have added this information to the manuscript, the sentence reads as follows: 'The levels for the Glenamong and Srahrevagh rivers were converted to volume of discharge per second (m3 s-1) using site specific ratings curves that have been developed using stream-flow data collected regularly, Glenamong R2 = 0.98, Srahrevagh R2 = 0.96 (Marine Institute unpublished data).' Comment: P7 line 6-8: Why two different tests? Response: We have reworded the sentence to clarify the reason for two different statistical tests, the sentence now reads. 'As the Black and Srahrevagh rivers are in the same river system, a non-parametric Wilcoxon Signed Rank Test was used to test for statistical differences between their colour concentrations.' Comment: P7 line 16-17: This sen-

tence needs to be rephrased. Should the second “for” be removed? Response: We agree, the sentence was poorly phrased, it now reads. ‘For a specific time series, colour concentration in surface waters can be expressed as:’ Comment: P7 line 21: I know many authors equal colored DOM and DOC but since only a (small) fraction of DOM actually is colored (see e.g. Ferrari et al., 1996) you might want to refer to CDOM here (and at other places where you use color to draw conclusions about DOC) instead. Response: We have found excellent relationships between DOC and colour in the Glenamong river (e.g. r2 = 0.88, $p \leq 0.001$, n = 366) and more recently in 2017 (r2 = 0.95, $p \leq 0.001$, n = 13) Comment: P7 line 23: General additive mixed models – this section is a little dense. Could you please divide it into a few paragraphs? Response: We agree. The section has been divided into 3 paragraphs in the manuscript: Comment: P8 line 6: Unit should be (m s-1). Response: We agree and the amendment has been made to manuscript Comment: P8 line 7: So the humidity here should actually be “relative humidity” Response: We agree and the amendment made to manuscript Comment: P8 line 8: How was actual evaporation estimated? Response: Soil moisture deficit (SMD) was calculated using a procedure described by Brereton et al. (1996) for Irish grasslands. Potential evapotranspiration rates were estimated based on air temperature and sunshine data using the method of Priestley and Taylor (1972) and then actual evapotranspitaion was calculated as a proportion of potential evapotranspiration based on Aslyng (1965) Comment: P8 line 18: I guess SMD is soil moisture deficit but the acronym has not been defined. Response: We agree. Soil Moisture Deficit (SMD) is now defined where it is introduced in the manuscript. Comment: P8 line 30: This should be rephrased. Water color was not converted but DOC was estimated from water color. I think you need to be clearer about this throughout the manuscript. Response: We agree. The sentence has been rephrased and now read. ‘DOC (mg L-1) concentration was estimated from water colour concentration (PtCo mg L-1) using a linear model developed between water colour and DOC from the Glenamong River between April 2010 and September 2011.’ Comment: P9 line 1: There should be a . after “sub-catchment rivers”. Response: We agree, the full stop has been added. Comment:

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P9 line 2: Is this really the accuracy? Or is it the precision? If this is the accuracy, what then is the precision? Also, on this line it should be “5 ppb”. Response: The precision of the instrument has been added: ‘DOC analysis was carried out using a Sievers 5310C Total Organic Carbon analyser (Range 4 ppb to 50 ppm, accuracy $\pm$ 2% or $\pm$ 5 ppb, whichever is greater; precision < 1% relative standard deviation).’ Comment: P9 line 3: New paragraph before “Mean annual yield. . .” Response: We agree, the amendment has been made to manuscript. Comment: P9 line 4-5: This sentence should be moved so that it precedes the previous sentence, i.e. first this sentence (starting with “The mean annual load. . .”) and then the sentence starting with “Mean annual yield. . .” Response: We agreed, the sentences have been moved and the section reads as follows: ‘The mean annual load was calculated by multiplying the calculated stream discharge volume for each week by the weekly DOC concentration and summing the totals. Mean annual yield (per km2) was estimated by dividing the mean annual load by the upstream drainage-basin area.’ Comment: P9 line 5: I am a bit confused here, but I think you mean the estimated DOC here, right? Response: We agree, the sentence was unclear. It now reads as follows. ‘The mean annual loads were calculated for the Black and Glenamong sub-catchments by multiplying the calculated stream discharge volume for each week by the weekly estimated DOC concentration and summing the totals.’ Comment: P9 line 8: Should it be “. . .year, with 2013 being the driest year, with. . .” or something similar? Response: We agree, the sentence now reads as follows. ‘Weather conditions varied during the six study years. 2013 was the driest year, with a mean daily precipitation of 3.7 mm day-1 and an annual total precipitation of 1315 mm year-1.’ Comment: P9 line 16-17: Do you really have the precision to report these numbers with one decimal? Above you did not use a decimal and I think you should be consistent here (also, how many decimals are realistic based on your measurement equipment?). Response: We agree with the reviewer, decimals have been removed and the sentence now reads: ‘The driest summer over the study period occurred in 2013 with 259 mm accumulated rainfall. The driest winter was also in 2012/2013 with 430 mm accumulated rainfall.’ Comment: P9 line 28: This would be easier to see if you

also report the specific discharge in e.g. mm/d.

Response: We consider that the discharge units of m3 s-1 is more intuitive for the readers. Comment: P10 line 5: But the cumulative SMD should have unit mm (only), right? Response: We agree, the sentence has been amended and now reads. 'The year with the greatest cumulative SMD was 2013 with an average daily deficit of 8.3 mm. The cumulative SMD reached a maximum of 66.2 mm in July.' Comment: P10 line 20-22: This "random component" does not seem to be entirely random, at least not from what I can tell from figure 3D. How does the autocorrelation of this random component look like? Would it be possible to subtract even more information from this time series (though I have no idea how to do that)? Response: We agree with the reviewer that the decomposed trend does not appear to be entirely 'random'. The random component is so named because it is the component remaining after the seasonal and multi-annual trends have been subtracted. This component appears to correspond with flood and drought ('random' in time) events over the study period. It is our understanding that these decomposed trends are strongly autocorrelated and can really only be compared visually, i.e. no further statistical analysis can be carried out on them. Comment: P10 line 25-28: This information seems misplaced. Why not combine this with the text in the beginning of this section where you also refer to which stream having the highest concentrations? Response: We agree with the reviewer. This section has been moved to the beginning of the section in the manuscript. Comment: P11 line 13: ". . .the optimal model. . ."?

Response: We agree, the sentence has been rephrased and now reads. 'The optimal GAMM for colour in the Glenamong River also had three smoothers, but differed in that it included the log of river discharge rather than SMD' Comment: P11 line 31: Not sure if I agree about discharge here. Based on figure 5, NAO, soil temp and water color seem similar but the increasing trend in discharge starts more than a year after the increase in NAO. Response: We agree with the reviewer that the 'dip' in the trend in water discharge starts more than a year after the NAO. Our aim here is to emphasise

how the trends in NAO, temperature, discharge and water colour have broadly similar patterns, however the timing was different for each. We propose the following change to the sentence. 'The multi-annual trend plots for the NAO, soil temperature, discharge and water colour all had broadly similar patterns that included a distinct dip in the period from late 2012 to late 2013 and a general upward trend after these low points (Fig. 5).' Comment: P12 line 20-25: This section is unclear. Is the second set of numbers reported (i.e. 18.5 and 11.8 t C km2 yr-1) averages among all the study streams? It is not clear how these differ from the first set of numbers (which apparently were for individual streams in individual years). Everything becomes clear when looking at Table 3 but it should be clear from the text as well. Also, sometimes you use the term yield and sometimes load – do these mean different things here? & P12 line 24: This sentence is a bit confusing. I think you should change this to ". . .while 2013 had the least total DOC load. . .". You have already reported that 2013 was the driest year – there is no need to reiterate that here. Response: We agree with the reviewer that the section is somewhat unclear. We propose to reword this section as follows. 'There was a wide range in the annual estimated loads exported from the three sub-catchments over the six study years. These ranged from a maximum DOC load of 38.6 t C km2 year -1 for the Srahrevagh sub-catchment during 2015, almost four times the minimum load of 11.6 t C km2 year -1 exported from the Glenamong sub-catchment in 2013. Also notable was the inter-annual variability of the total calculated load from all sub-catchments, whereby 2011 had the greatest total DOC load of 18.5 t C km2 year -1 while 2013 has the least total DOC load of 11.8 t C km2 year -1. Comment: P12 line 28-29: You should rephrase this sentence. It is unclear, probably because of the misplaced modifier "which" that refer to "DOC levels" or possible to "water colour" in this case. I also think you should change the statement "explained circa 60%" to "explained between 54 and 66 %". Response: We agree with the reviewer and we have amended the sentence as follows. 'This study highlighted the dominant influence of local and regional climate on water colour, which as a proxy for DOC levels, explained between 54 and 66 % of the variability in all three datasets, and the strong synchronic-

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ity in these climate signals across the Burrishoole catchment.' Comment: P13 line 2-3: Though I suspect you are right, do you have data to confirm this statement? Do you e.g. have fluorescence data that indicate that DOC primarily is of terrestrial origin? If not, I think you should be more careful and write something like ". . .probably originates primarily from the surrounding catchment. . .". Response: We agree with the reviewer, and we have amended the sentence as follows. 'Colour, and therefore DOC, in these headwater rivers probably originates almost exclusively from the surrounding catchment soils' Comment: P13 line 3-6: If I understand this sentence correctly you claim that you have shown that the DOC export from the different study catchments in your study are related to catchment properties, land use, runoff etc. But this is incorrect, you have not shown this. There are no data that show these relationships. Response: We agree with the reviewer and we have rephrased this sentence, removing the reference to DOC export. The sentence now reads as follows. 'Colour, and therefore DOC, in these headwater rivers probably originates almost exclusively from the surrounding catchment soils and the consistent difference in colour concentrations between each sub-catchment during the study was most likely a function of individual sub-catchment properties such as the extent of peat within catchments (Hope et al., 1997a), land use (Findlay et al, 2001), local runoff (Dillon and Molot., 2005) vegetation type (Sobek et al., 2007) and the unique morphology and geology of the sub-catchment landscape (Moore, 1998).' Comment: P13 line 8-10: But you do not present such an analysis – you only have three sites, so the statistics will be a little shaky, but can you find any of these relationships that you mention? Figures in an appendix could be enough to show if there are any relationship between water color and e.g. the extent of peat soils in the catchment. Response: We agree with the reviewer and we have rephrased the sentence to remove any mention of spatial analysis, the new wording is a follows. 'The extent of peat soils in the study catchments, the length of streams intersecting the peat, slope analysis and CORINE land cover in each sub-catchment (Table 1) may help in explaining the higher levels of colour found in the Srahrevagh'. Comment: P13 line 14-17: Perhaps, but other studies have not found any clear downstream patterns

in DOC concentration (see e.g. Temnerud & Bishop, 2005 and Creed et al., 2015) or clear signs of DOC degradation as water moves downstream in a stream network (see e.g. Winterdahl et al., 2016). Response: We agree with the reviewer that there are conflicting bodies of work on this point. We propose to add the following sentence to the end of the section: 'An additional factor that may have influenced the variation in colour between the sub-catchments could be the distance between a given sampling point and the source of any coloured compounds. Dawson et al. (2002) observed decreases in TOC (both DOC and POC) concentrations in the Upper Hafren (a headwater stream in mid-Wales) downstream from the source that were stated to be related to a decrease in peat depth with altitude, combined with in-stream processing of DOC. A similar process may contribute to the difference in concentration between the upstream Srahrevagh and downstream Black sampling points. There are however other studies that suggest no clear change in DOC concentration or degradation as water travels downstream (Temnerud & Bishop, 2005 and Creed et al., 2015, Winterdahl et al., 2016).'

Comment: P13 line 21-23: Is it necessary to reiterate the results here? & P13 line 24: Wouldn't Christ and David (1996) and Neff and Hooper (2002) be more relevant references here since they have actually looked at the relationship between temperature and DOC "production/leaching". Response: We agree with the reviewer. We have amended the sentence and added the suggested references. It now reads as follows. 'Soil temperature was common to all three GAMMs, and was the dominant explanatory variable, emphasising how dissolved organic carbon is released by peat soils via decomposition processes that are temperature dependant (Christ and David, 1996; Neff and Hooper, 2002).' Comment: P13 line 28-30: You touch upon this but it could perhaps be clarified. You need to think of what you, and most other scientists in this business, refer to as "DOC production" as two different processes (if we simplify everything and ignore e.g. sorption dynamics, solution/dissolution due to changes in water chemistry etc.): 1) the actual DOC production, i.e. some process that forms DOC (could be e.g. exudation of organic molecules through roots or microbial degradation

of solid organic matter), and 2) transport of DOC along active flow pathways in the soil. Process 1) could be active as long as there is water in the soil, even if this water is not moving. Process 2) only happens when the water is actually moving. That is, you could have an area with stagnant soil water where DOC production (process 1) forms a "stock" of DOC that is transported to a nearby surface water body as soon as the flow pathways are activated. Response: We agree with the reviewer on this point. We propose to rewrite as follows: 'The lowered water table, however, reduces the hydrological connection, i.e. the transport of DOC along active flow pathways in the soil (Ryder et al., 2014) This breaks the connection between the source of DOC production and its eventual destination.' Comment: P13-14 line 33-1: But this is not generally the case for DOC, see e.g. data from about 130 streams in Winterdahl et al. (2014) where there is no relationship between seasonality and DOC concentration.

Response: We agree with the reviewer and we propose to rewrite as follows. The strong relationship found between soil temperature and water colour concentrations in the three rivers, and the significant and high common power with river colour at the yearly time scale in the cross-wavelet analysis, indicated that soil temperature was the primary driver of the seasonal pattern in water colour during the study period. It is interesting to note that in general no relationship between seasonality and DOC concentration has been reported from some other studies commonly observed (e.g. Winterdahl et al. 2014). However, our results are consistent with observations of DOC dynamics in some surface waters in temperate peatlands, where seasonal variation has been found to be the largest source of DOC variation in catchments with high DOC concentrations (Clark et al. 2010; Ryder et al., 2014). Comment: P14 line 6: As I understand this, you mean that since concentrations decrease, the export will also decrease. In this case, this is probably true since if soil moisture decreases, stream discharge will also likely decrease. But generally, you can have decreasing concentrations but increasing export if discharge increases. Since discharge on event scales can vary by several orders of magnitude whereas concentrations seldom vary by more than a factor 10, discharge often control the export dynamics, at least on short

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time scales. Therefore, I think you should remove ". . .and therefore export. . ." here. Response: We agree with the reviewer, we have amended the sentence and it now reads: reads. 'The relationship of colour with SMD in the Black and Srahrevagh optimum GAMM models indicated that as soil moisture decreased DOC concentrations also decreased.' Comment: P14 line 21: Change to ". . .DOC concentrations have been observed in peatland streams. . ." Response: We agree with the reviewer, the sentence has been amended and it now reads. 'However, immediately following periods of dry weather or drought, pronounced increases in DOC concentrations have been observed in peatland streams'

Comment: P14 line 13-23: I agree that the effect of hydrology on DOC dynamics is complex and that there is probably a multitude of interactions. One interaction that you do not discuss is the effect of different flow pathways at different discharge conditions (see e.g. Bishop et al., 2004 and Seibert et al., 2009). If you have more organic rich soils close to the soil surface compared to deeper soils, one could expect that concentrations are higher at high stream discharge compared to at low stream discharge. What do the relationship between log(color) and log(discharge) look like? Positive, negative or neither? For Glenamong, which is the only site where you report a similar relationship, this looks complex but generally positive. There are several studies that have looked at such C-Q relationships (see e.g. Creed et al., 2015; Musolff et al., 2015; Moatar et al., 2017; and Winterdahl et al., 2014). Response: We agree that this is indeed an interesting interaction, however as discharge was found to be in the optimal model for the Glenamong sub-catchment only, we do not intend to discuss different flow pathways at different discharge conditions further in the manuscript. Comment: P15 line 23-24: ". . .warm and dry rather than warm and wet conditions. . ." Response: We agree with the reviewer and the sentence has been amended, it now reads. 'However, some studies have also suggested that positive phases of the NAO during the summer are associated with warm and dry rather than warm and wet conditions over northwest Europe in particular the UK and much of Scandinavia (Folland et al. 2008).' Comment: P15 line 26: ". . .time-series analysis at the annual. . ."? & P15 line 27:

remove the . before “both” Response: We agree with the reviewer and the sentence has been amended, it now reads. ‘However, the negative relationship apparent in the cross-wavelet time-series analysis at the annual time step may also merely reflect the fact that both time series have seasonal patterns, but are not linked by any causal mechanism.’

Comment: P15 line 30: Colder and drier than what? Change to “. . .to relatively cold and dry conditions, and dry weather. . .” Response: We agree with the reviewer and the sentence has been amended, it now reads. ‘Negative NAO values during the winter generally correspond to relatively cold and dry conditions, and dry weather was observed throughout 2013, reflected in the SPI Index, beginning during the winter of 2012/2013.’ Comment: P15 line 31: “Cold conditions. . .” Response: We agree with the reviewer and the sentence now reads. ‘Cold conditions were also confirmed by the sharp dip in the multi-annual trend of soil temperature observed during the same winter period.’ Comment: P16 line 5: “. . .minimum annual total DOC yield. . .” Response: We agree with the reviewer and the sentence now reads. The minimum annual total DOC yield from the Burrishoole catchment was. . . Comment: P16 line 7: New sentence at “However. . .” Response: We agree and have amended that manuscript. Comment: P16 line 8-9: Perhaps true, but your case would be stronger if you could show this with data and statistics – are there any relationships between annual export and e.g. NAO, precipitation or temperature? Response: We agree with the reviewer and have amended that manuscript to remove any references to carbon export being linked to climate factors.

Comment: P16 line 16-17: Again, this is not something you have shown with data and statistics. However, you may not have the data to actually show this since you only study three streams. I think you should de-emphasize the spatial patterns and concentrate on temporal patterns. Response: We agree with the reviewer and have reworded sections of the discussion to concentrate on temporal patterns only, and de-emphasising spatial patterns. ‘The results of this study emphasised how colour

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concentrations, and therefore DOC levels, respond to common climatic drivers which operate at both a local and regional scale.' Figures and Tables: Comment: Figure 1: The figure text should start with a capital letter. Response: This has been amended in the Figure. Comment: Figure 2: There is a parenthesis, which should be removed, at the end of Standardised Precipitation Index on the axis label in A. Also, should the unit for Soil Moisture Deficit (on the left axis) be mm/d? Response: Parenthesis has been removed and the units on the left axis have been corrected. Comment: Figure 4: What are the units on the axes (if any)? Another detail, in previous figures you have indexed sub-figures (panels) with capital letters but now you use lower-case letters. I think you should be consistent. Response: Units have been added to the figure and the panels have been indexed with upper-case letters. Comment: Figure 5: What is actually displayed in these figures? The text gives some information but there is nothing on the vertical axes – should there be labels and units here? And in e), is that some composite trend (how was that done?) since you write that this is "mean colour concentration in the three sub-catchment rivers"? Response: Labels and units have been added on the vertical axes for each panel. The bottom panel (E) shows the decomposed multi-annual trend (STL) of mean colour concentrations from all three catchments over the study period. Comment: Figure 6: I would prefer to use letters to name the different panels instead of writing e.g. "bottom left". There is a) missing after "top left". Response: We have added index letters A, B, C and D to Figure 6 and updated the caption to correspond with the figure. Comment: Table 1: The table text should start with a capital letter. Also, what do numbers within parentheses mean? Are those standard dev.? If so, why are you reporting ranges for some parameters but means + std. dev. for others? In addition, I guess the water chemistry data is for stream water but I think it would be good if you clarify this in the caption. What does (312) mean after CORINE Coniferous Forest %? Response: Table text has been revised to start with a capital. The numbers in parentheses are standard deviations, the caption has been updated to reflect this. Stream water chemistry has been added to the caption to clarify. The (312) has been removed from the table. Comment: Table 2: The table text should start with a

capital letter. Also, should there be a , after Table 2? Here you write that the data cover 2011-2017 but from the main text I got the impression that data was from 2011-2016. Which is correct? In addition, I think it would be clearer if you used the same acronyms in this table as you use in the main text, i.e. SMD for soil moisture deficit, NAO and only Stemp100 (instead of s(Stemp100)). What does s(. . .) mean anyway? Is that what is reported by R? Response: Table text has been revised to start with a capital. Comma has been added. Date range has been revised in the table (2011 – 2016). We agree with the reviewer and the acronyms in the table have been amended to correspond with the main text. Comment: 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” Response: All the above typos have been corrected. References: Aslyng H. C., 1965. Evaporation, evapotranspiration and water balance investigations at Copenhagen 1955–64. Acta Agric. Scand., 15: 284-300. Brereton, A .J., S. A. Danilov and D. Scott, 1996. Agrometerology of grass and grasslands in middle latitudes. Technical note no. 197. World Meterological Organization, Geneva, p. 36. Priestley C. H. B. and R. J. Taylor, 1972, On the assessment of surface heat flux and evaporation using large-scale parameters. Mon. Weather Rev.100: 81-92. Ryder, E., de Eyto, E., Dillane, M., Poole, R., and Jennings, E.: Identifying the role of environmental drivers in organic carbon export from a forested peat catchment, Sci. Total Environ., 490: 28–36, 2014.

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