Interactive comment on "Dynamics, chemical properties and bioavailability of DOC in an early successional catchment" by U. Risse-Buhl et al.

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K. Cawley (Referee)

Overall this manuscript presents a study that is of interest to the readers of Biogeosciences. The authors present a novel study of the DOM characteristics and bioavailability of a recently constructed stream and pond ecosystem. The quality of the methods is excellent for the most part and the study is well written. The title accurately reflects the content of the manuscript.

Comment: The abstract seems a little misleading. The authors state in the manuscript that "the ^{13}C signature of the DOC -25 to -30 ‰ indicates that recent organic matter derived from C_3 plants and microbial exudates was a substantial fraction of the DOC pool", but the abstract states that "The ^{14}C age and ^{13}C NMR spectra suggest that DOC was partly mobilized from charred organic matter of the Quaternary substrate" and does not additionally state that there are modern inputs, especially that there are substantial modern inputs to the DOM pool in the pond sample.

Response: We have revisited the issue and will revise the abstract and respective paragraph in the manuscript accordingly (see also responses considering DOC age to comments of A. Butturini).

Comment: A map showing the location of the upwelling, downwelling, and perched water sample sites would enhance the manuscript and help readers better understand the study site.

Response: We will add an illustrated aerial photograph showing all sampling points as suggested by both Referees (please refer to Fig. 1 in the response to comments of A. Butturini).

Comment: The differences between Chicken Creek and literature of other "early-successional" catchments in the DOC discussion section may deserve a little more attention. The site of this study seems like it is really a "constructed" or "reclaimed" system and has some important differences than the natural systems from the cited literature. It seems like the high DOC and more modern source of the DOM in Chicken Creek could be due to differences between constructed versus natural early-successional catchments. The effects of dumping are mentioned on page 1029, line 12-14 and there may be much more surface area for sorption or leaching of aquatic DOM to/from the soil and also more surface area for microbial colonization in an area that has been disturbed and then re-constructed compared to a recently de-glaciated ecosystem.

Response: We concur that substrate disturbance could influence DOC dynamics in the experimental Chicken Creek catchment, accounting for higher DOC concentrations than found in some natural early-successional catchments (e.g. in glacier forefields; Guelland et al., 2013, Biogeochemistry). We will slightly expand the discussion on this issue while attempting to minimize speculation.

Comment: It is unclear what "these conclusions" are on page 1029, line 1. Based on the previous paragraph there are two different relationships between ^{14}C age and DOM bioavailability discussed: older ^{14}C age leads to greater DOM bioavailability page 1028, line 20 or that older ^{14}C ages lead to greater turnover times page 1028, line 24. It is not clear which relationship the authors are suggesting predominates in the Chicken Creek catchment.

Response:

- "These conclusions…" refer to the results of ^{14}C measurements and the likely origin of DOC in the Chicken Creek Catchment derived from these measurements. We will revise the beginning of the paragraph.
- Studies in early-successional landscapes of melting glaciers suggest a positive correlation between the ^{14}C age and the bioavailable fraction of the DOC, whereas results from grassland and forest soils suggest that bioavailability decreases during soil passage and along hydrologic flow paths. In the early-successional Chicken Creek Catchment, the ^{14}C and ^{13}C NMR measurements indicate that part of the DOC is derived from old charred organic material and another significant fraction is of modern origin. The bioavailable fraction of the DOC in the Chicken Creek Catchment estimated at about 20% implies that DOC in the early-successional landscape is less bioavailable than that of early-successional glacier-fed landscapes but comparable to that of landscapes in much later successional stages. One reason for the relative lower bioavailability compared to other early successional catchments might be the release of highly aromatic DOC from charred material inherited in the Quaternary substrate. We will revise the section to clarify this issue.

Comment: The $SUVA_{254}$ values for the soil solution may be influenced by the presence of iron (Weishaar et al., 2003) since the value is above 5 and the groundwater may be in contact with iron containing minerals since the authors state that there are "iron oxide deposits indicating reducing conditions". The authors do not draw any particularly strong conclusions from the SUVA values and may want to consider removing that or discussing it in more detail in the context of metal interference. It seems that the aromaticity could be calculated from the ^{13}C NMR and used in the NMDS instead of the $SUVA_{254}$ values.

Response:
- All $SUVA_{254}$ measurements were performed on filtered water to remove particles such as Fe(III) precipitates, as suggested by Weishaar et al. (2003, Environmental Science & Technology). Furthermore, dissolved iron was lower than 0.1 mg L^{-1} in all studied water types. According to Weishaar et al. (2003), Fe at this concentration does not interfere with the analysis, adding < 0.01 cm^{-1} to the UV absorbance of water samples at 254 nm. We will add this information in the revised manuscript.
- In the bioavailability experiment, ^{13}C NMR was not applied because the required water volume of at least 5 L could not be sampled. Therefore, we could only use the $SUVA_{254}$ data as a proxy of aromaticity and molecular weight and are hence reluctant to discard those data.

Comment: In the NMDS plot of Figure 6 there are two mis-matches between the abbreviations used in the caption and the figure. I do not see any "ip" samples plotted in the figure, but there are unidentified "-il-" samples in the figure. Those differences should be reconciled. I assumed that the il samples were pond water microbial community samples. Also, the caption states that there should be "ug" samples and they are labelled "gw" in the figure.

Response: We will correct these regrettable mismatches in the figure.

Comment on Technical Corrections: Line 27, page 1028 should be revised to read "carries" instead of "carryies"

Response: The typo will be corrected.

Literature cited

Guelland, K., Hagedorn, F., Smittenberg, R.H., Göransson, H., Bernasconi, S.M., Hajdas, I., and Kretzschmar, R.: Evolution of carbon fluxes during initial soil formation along the forefield of Damma glacier, Switzerland, Biogeochemistry, 113: 545–561, 2013.

Weishaar, J.L., Aiken, G.R., Bergamaschi, B.A., Fram, M.S., Fujii, R., and Mopper, K.: Evaluation of specific ultraviolet absorbance as an indicator of the chemical composition and reactivity of dissolved organic carbon, Environ. Sci. Technol., 37, 4702-4708, 2003.