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Interactive comment

Interactive comment on "Dissolved organic matter characteristics of deciduous and coniferous forests with variable management: different at the source, aligned in the soil" *by* Lisa Thieme et al.

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Thank you for your detailed review of our manuscript. In the following, we hope to adequately address your constructive comments and questions.

"Yet, one major shortcoming of the manuscript is that the properties of the soils of the study sites are not well described. There is some information about parent material and soil type given in the supplementary material, however, in my opinion a study on DOM in subsoil requires more detailed information about soil properties that may strongly affect the movement of DOM such as soil texture, mineral composition of the reactive clay fraction and pH (i.e., properties known to determine the chemistry of sorption

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Discussion paper

processes). Hence, the focus of the discussion is a bit too much on biological factors of DOM movement, while the geo-chemical controls of soil processes should be covered a bit more. In case the data on soil mineralogy and chemistry are not available, I suggest to (at least) enhance the discussion on basis of available literature about how differences or similarities in geo-chemical factors between sites might have influenced the results of the present study. For instance, a decrease in highly oxidized compounds (page 15, line 21) might be explained by binding of the carboxyl-groups to positively charged surfaces of Al-/Fe-oxides at acidic pH values. In my view, the conclusion that the alignment of the composition of DOM is due to biotransformation and "interaction with the soil solid phase" needs support by considerations about such processes"

Being part of the DFG priority program 1374 offered the unique opportunity to access various kinds of information about the study sites. Therefore, it was possible to add additional geochemical information like soil texture and elemental composition. We will add the the new table S2 you can find in the supplement to this reply to the supporting information.

To assess whether geo-chemical processes controlled the DOM quality in our study, we additionally examined the relation between changes in DOC concentration and the ratio between organic carbon content of the mineral soil and the sum of its oxalate-extractable Fe- and Al-content (OC/[Feo+Alo]) and compared the results with findings of Kindler et al. (2011).

We will ad Fig.1 of these reply as new Fig.2 to the manuscript We therefore will expand the discussion section as follows:

Page 13 Line 13: In the study of Kindler et al. (2011), the retention of DOC in mineral soil, expressed as percentage reduction of downward DOC flux, was closely related to the ratio between organic carbon concentration of the mineral soil and the sum of its oxalate-extractable Fe and Al content (OC/[Feo+Alo]). This suggests that the DOC retention in mineral soils is governed by the sorption to the surfaces of Fe- and

Al-(hydr)oxides. Furthermore, organic matter sorption decreased exponentially with increasing organic matter coverage of the hydroxide surfaces (Kindler et al. 2011), which suggests that these hydroxides have a limited DOC sorption capacity (our hypothesis ii). In contrast to the findings of Kindler et al. (2011), we compare DOC concentrations, not fluxes. In order to test whether the data of our study fit the findings of Kindler et al. (2011), we plotted changes in DOC concentrations reported by Kindler et al. (2011) together with the data of this study against the ratio of OC/(Feo+Alo) in one graph (Figure 2). Different from fluxes, which always decreased with increasing soil depth in the Kindler et al. (2011) study, DOC concentrations increased with increasing depth at the Hainich sites with the highest OC/(Feo+Alo) ratios of all study regions (Figure 2). This increase in concentrations can be explained by a concentration effect because of evapotranspiration, if the DOC sorption capacity of pedogenic Fe- and Al-(hydr)oxides is saturated. Overall, the retention of DOC in the Hainich soils of this study fitted well to the DOC retention in the European data set of Kindler et al. (2011), who showed that the regional variation in DOC retention can be as large as the variation at continental scale. The concurrent decrease of DOC concentrations and increase of OC/(Feo+Alo) ratios between TOP and SUB ($p = 0.027$; Figure 2), corroborates the hypothesis that sorption to pedogenic Fe- and Al-(hydr)oxides controls DOC retention in mineral soils (Kindler et al. 2011). However, the results for mineral soils of the Schorfheide sites did not meet this pattern, as DOC concentrations decreased from TOP to SUB by 33-72% regardless of the OC/(Feo+Alo) ratio (Figure 2). At the Schorfheide sites, other processes than sorption to Fe- and Al-(hydr)oxide surfaces likely governed DOC retention. The Schorfheide soils developed from fluvioglacial quartzitic sands covering carbonate-free glacial till. Because of their poor pH buffering capacity, these soils were very acidic (pH_{CaCl2} = 3.0 – 3.6 in topsoils). The mean pH values in soil water samples of the Schorfheide sites was 4.5 in TOP solutions, increasing to 5.5 in SUB solutions. This means that Al-(hydr)oxides were dissolved in the Schorfheide topsoils, increasing Al^{3+}-concentrations in soil water and leachates. The pH increase to 5.5 along the way from TOP to SUB likely induced a re-precipitation of Al. We assume that dissolved organic matter transported from TOP to SUB co-precipitated together with Al3+ as described by Nierop et al. (2002) and Jansen et al. (2003, 2005) for acidic sandy soils from the Netherlands. If DOM was immobilized as insoluble metal-organic matter precipitate in B horizons, sorption sites on surfaces of pedogenic (hydr)oxides may be less important.

The following references will be added to the manuscript:

Jansen, B., Nierop, K.G.J., and Verstraten, J.M.: Mobility of Fe(II), Fe(III) and Al in acidic forest soils mediated by dissolved organic matter: influence of solution pH and metal/organic carbon ratios. Geoderma, 113, 323– 340, 2003.

Jansen, B., Nierop, K.G.J., and Verstraten, J.M.: Mechanisms controlling themobility of dissolved organic matter, aluminium and iron in podzol B horizons. Eur. J. Soil Sci., 56, 537–550. doi: 10.1111/j.1365-2389.2004.00686.x, 2005.

Nierop, K.G.J., Jansen, B., and Verstraten, J.M.: Dissolved organic matter, aluminium and iron interactions: precipitation induced by metal/carbon ratio, pH and competition. Sci. Total. Environ., 300, 201–211, 2002.

"Page 3, Line 27: The hypotheses could be stated more precisely, i.e., currently a broad predicition is made ("DOM changes systematically") without any consideration about the main mechanisms. How and why should the composition and biodegradability of DOM change along the water pathway? How and why should tree species and forest management affect these changes?"

To state our hypotheses more precisely we will change the manuscript as follows:

Page 3 Line 27: We hypothesized i) that the composition and the biodegradability of DOM changes to less polar, highly aromatic compounds with decreased bioavailability along the water flow path through forest ecosystems, from throughfall (TF), stemflow (SF), litter layer leachate (LL) to mineral topsoil (TOP) and subsoil (SUB) solution. We postulated ii) that aboveground changes of DOC concentrations and DOM composition are mainly controlled by selective biological degradation, while changes in mineral soil are governed by sorption to mineral surfaces. Moreover, we hypothesized iii) that main tree species as well as forests management intensity affect the DOM composition as well as the direction and magnitude of its changes. The former because of the presence of species-specific compounds in DOM like phenolic secondary metabolites in beech forests, the latter, measured as the Forest Management Index (ForMI), beside others because of its influence on the biomass production and C input into the soil (Kahl and Bauhus, 2014).

"Page 3, Line 30: I suggest to briefly explain the ForMI here so that the readers can gain a better understanding of the study approach."

The ForMI is explained now in more detail on page 4, lines 15ff of the revised manuscript.

"Page 4, Line 17: The work of Fischer et al. is not given in the reference list."

Thank you for pointing this out. The reference will be added in the reference section

"Results section: Although it is not the focus of the manuscript, it may be interesting to briefly summarize the magnitude of the temporal differences in DOC concentrations in the text (e.g., between the years and over the vegetation period); it is not clear to me whether the temporal differences are mirrored in the standard deviations shown in Figure 1?"

The temporal variation of the DOC concentration is indeed an interesting topic. Considering that we have five ecosystem fluxes and three different management categories for each of the four years, even a brief summary encompasses a lot of additional data. Adding this information to the result section without further discussion (because we agree, it is outside the focus of this manuscript) would only hinder the understanding of the manuscript. We plan to address this topic in a separate manuscript.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-478/bg-2018-478-AC1-supplement.pdf

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Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-478, 2018.

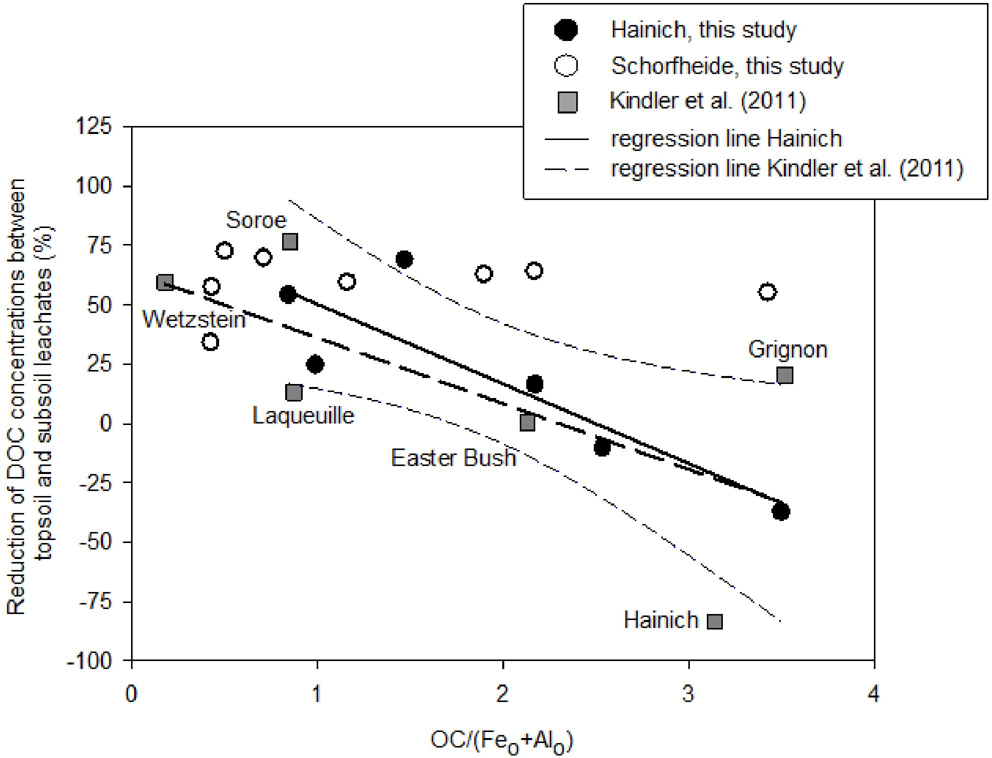

Fig. 1. Figure 2: Percentage reduction of DOC concentrations between topsoil (TOP) and subsoil leachates (SUB) as a function of carbon saturation of pedogenic Fe- and Al-(hydr)oxides. For the Hainich sites (t