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Interactive comment on "Carbon accumulation in a drained boreal bog was decreased but not stopped by seasonal drought" *by* Kari Minkkinen et al.

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"General comment: The authors present a convincing dataset and sound reasoning in a comprehensive study which will be without doubt controversially discussed. The results are convincing, but I still find it puzzling to read about C accumulation rates of this magnitude without seeing a moss or shrub layer developing. Therefore, I think that the authors should spend more effort in discussing possible remains of the stored soil carbon."

–Moss and shrubs are still present in the peatland (p. 2, r 35-38) and they are growing vigorously, producing a lot of litter (p. 11, r. 17-22).

"Is there possibly a reallocation of rhizosphere or subsoil organic carbon?"

–Yes, very probably. Root growth is a very important input of C into the peat soil (p. 11, r. 20).

–Add: When decomposed, part of the released C is translocated as a solute into deeper peat layers (Domisch et al. 2000).

"Is the bulk density increasing? "

–We do not have bulk density measurements from Kalevansuo peatland prior to drainage, but compared to similar pristine sites (38 kg m-3 natural treed fens (Minkkinen and Laine 1998), bulk density of the surface 0-20 cm layer is higher in Kalevansuo (94 kg m-3). It is therefore likely that bulk density has incresed after drainage, as "is evident in all drained peatlands (e.g. Minkkinen and Laine 1998)" (p. 11, r. 2).

"Are soil pores being filled with particulate organic matter?"

–We have no observations of this phenomenon. However, this is one of the consequences of decomposition, leading towards higher bulk density.

"Is the assumption that export of DOC/POC is negligible, reasonable?"

–Leaching of DOC, i.e. the output of dissolved C from Finnish drained peatlands varies between 10 to 15 g C m^{-2} a^{-1} (Sallantaus and Kaipainen, 1996; Kortelainen et al., 1997; Sarkkola et al., 2009; Rantakari et al., 2010). This is 4–7% of the estimated NEE and 17–25% of soil C balance in Kalevansuo. The smaller the soil C balance the higher the share of DOC export naturally becomes. However, the input of DOC into forest soils is of the same magnitude as the output. According to Lindroos et al. (2008) Finnish forest soils receive 2–6 g C m^{-2} a^{-1} dissolved C as deposition in stand throughfall and in 2–10 g C m^{-2} a^{-1} percolation water. Kalevansuo is mainly ombrotrophic, so that DOC in percolation water is insignificant. However, as mentioned earlier, ditches in Kalevansuo are ineffective and transpiration of the tree stand is likely an important pathway for water output in such a case like Kalevansuo (Sarkkola et al. 2010) decreasing the possibility for big DOC losses. It is thus likely that net export of DOC does not have a major significance for the C balance at Kalevansuo peatland.

"I appreciate that, for site and methods information, the reader is referred to Lohila et al. (2011). However, even if this means repeating things, I suggest adding basic information on a couple of things: When and how was the stand set up? How deep and how strongly decomposed is the peat? Please give some basic information on peat properties. This is important for the discussion that, I think should be somewhat enhanced."

–It is not entirely clear if the referee means the history of the tree stand, or the setup of measurements. The description of both can of course be added, e.g.:

–The site has been naturally forested long before drainage as evidenced by seemingly very old scattered stumps of Scots pine found in all parts of the site. Tree ages of the present Scots pine stand, as determined in 2005 from increment cores extending to tree pith of some sample trees at the height of 1.3m and assuming 15 years to reach that height, varied from 67 to 179 years with an average of 120 years (n=7).

–The site was set up for C flux measurements in June-August 2004. Collars were inserted, litter collected and plants removed from the treated collar plots in June 2004. The eddy covariance tower was erected in August 2004.

–Peat depth, measured from the 33 sample plots varied from 1.3 to 3.0 metres, average being 2.2 m. Mean peat bulk density was 94 kg m-3 in the 0-20 cm layer.

–The peat (prior to drainage) in the area of EC footprint is composed mainly of the remains of Sphagna (Sphagnum fuscum, S. magellanicum), Ericaceous shrubs and cottongrass (Eriophorum vaginatum) (Mathijssen et al. 2017). After drainage the re-

mains of forest mosses and woody roots have increased their share in surface peat. Drainage has increased surface peat oxidation which is seen as a shallow layer of more decomposed peat about 10-20 cm below surface. Remains of several forest fires are also present especially in the surface layers 30-50 cm, where a charcoal layer is clearly visible, but also in the deeper layers from 70 to 180 cm. Forest fires have thus significantly decreased the long-term rate of C accumulation into the Kalevansuo peatland (Mathijssen et al. 2017).

"Were chamber measurements done with opaque chambers to prevent photosynthesis by shrubs? How high were the chambers to make shrubs fit inside them?"

–Chamber measurements were done with opaque chambers to measure dark respiration. In this study photosynthesis was not measured. CO_2 chamber was 14.9 cm high. In plots with vascular plants we used 5 cm and 10 cm extra collars to fit the plants in the chamber. The chamber volume was corrected accordingly.

"2.2.3 How can you be sure that 7 CH_4 flux calculations in a 6 month period are sufficient to derive a correct estimate for CH_4 efflux? How can you assume that CH_4 fluxes reported by Lohila (2011) can be applied to a later time? I think that it is not correct to apply measurements done at an earlier time for other time periods, unless properly modelled. This is not decisive for the main message of the manuscript but should still be described some more."

–Methane flux on drained peatlands is quite well studied. Fluxes from strips are always small, often negative (see e.g. the synthesis of wetland CH_4 emissions by Turetsky et al. 2014). Kalevansuo is not an exception in this rule. Annual variation was small, average flux estimates from the highest flux months July-September were almost same in the years 2004 (-11.04 mg m-2 month-1) and 2005 (-11.98 mg m-2 month-1). It is improbable that other years would have remarkably changed the flux. The new measurements from ditches were from a short period, but they did cover the high and low flux seasons (Minkkinen and Laine 2006) and they revealed that accounting ditches did not significantly change the areal flux estimate. The total CH4 flux remained negative. Much higher emissions from ditches would have been needed to change the conclusions. As carbon, the CH4 fluxes are negligible compared to all other C fluxes in Kalevansuo. Although modelling CH4 fluxes would be interesting, it has no relevance for this study.

"P 7, L 16: A “high NEE” implies a high CO2 uptake, but this is not the case here. Please avoid this expression here. You could say “lower net CO2 uptake”, if this is what you mean to say."

–We have tried to use NEE unambiguously so that negative NEE indicates C uptake and positive net emission (p. 4, r.10). Thus high NEE means high CO2 emission. We can however change this expression to "lower net CO2 uptake" as suggested.

"P 14, L9: “making up”, not “making” "

–OK. Changed accordingly.

"P11, L24-25: I am not so sure that, when trees die, root carbon becomes part of the soil C pool. After harvest, there is usually large C release from this C pool. "

–This is conceptual debate. We mean that when trees are cut, roots and the C in their structures, remain in the soil until they are decomposed. Thus, they temporarily become part of the soil C pool. Here we refer to roots > 1cm which would not be as fast decomposed as the fine roots.

"P12, L7: That ["soil is currently a C sink"] depends whether you assume root carbon to remain in the soil following harvesting. Last paragraph on page 12: Exactly, this remains to be seen! "

–The word "currently" refers to the current situation, when trees continue growing and cuttings have not been done. Situation after a possible harvesting is another issue, as discussed later. (p. 12).

"P13, L3-4: I don’t think that your data justifies saying that the drained peatland stores AT LEAST as much C as undisturbed peatlands. Are you referring to the mean long term C storage of all peatlands here? You are able to conclude that, in a very limited time of the lifecycle of the rotation, there is a soil C sink, even under meteorologically variable seasons. "

–OK. Yes this was based on long-term accumulation values from natural peatlands, which is (according to Clymo’s (1984) conceptual model of peat bog growth, and supported by many observations (e.g. Tolonen and Turunen 1996, Clymo et al. 1998, Turunen et al. 2002)) in bogs bigger than the actual, current accumulation. However, as the actual accumulation rates are not accurately known for either natural mires or for Kalevansuo peatland, we will change "at least as much" to "similar to".

"Figure 2: Please don’t display precipitation by drawing straight lines between the months. A bar graph is much more adequate. "

–We agree that bar graph is usually more adequate for such a discontinuous data like monthly precipitation. However, in this case with the same legend in multiple graphs, we think that line drawing is a better choice. It is easy to quickly see the differences between years in all variables.

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