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Interactive comment on "Are C-loss rates from drained peatlands constant over time? The additive value of soil profile based and flux budget approach" *by* J. Leifeld et al.

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This study focusses on carbon loss from drained peat soils in NE Germany. The paper applies different methods to estimate C losses over long historic and short recent time intervals. It concludes that losses have increased in recent time after drainage and management were intensified. The main conclusion that land management and climate change outweigh the state of decomposition of the peat and are the likely main drivers behind further oxidation and associated C-losses is important. Though not entirely surprising, this conclusion does underline the strong anthropogenic influence on soil emissions. The paper is within the scope of BG. It is well argued. Some issues need

the attention of the authors before publication, however.

The comparison of methods reveals that the profile based method used in the paper is suited to estimate long term rates of subsidence and C loss. However, a discussion on possible pitfalls is missing. The method is not suited for highly mineral peats or peats that have received input of clastic material to the upper layers (not uncommon in NE Germany), which in combination with ploughing, would imply very high rates of mineralisation. The authors should discuss their findings in the light of published records of historic subsidence and associated loss of organic matter. The data of Mundel (I much applaud the use of these old data), cited to support the argument that C loss increased over time, is not well explained and the relationship shown in Fig. S2 may be trivial; see below for a discussion on this point. The authors would do well to have their manuscript checked by a native speaker. The text can be tightened considerably to improve its style in clarity and readability.

Following are some detailed remarks and suggestions: (1) p. 12343, l. 5: 'which cover different system boundaries in time and space': this phrasing is oblique and I suggest you are either explicit or delete. The methods you applied cover different time periods with differing temporal resolution. The profile based method focuses on the soil only, whereas the chamber based method derives changes in soil carbon from larger ecosystem fluxes.

(2) p. 12343, l. 14: delete 'former'.

(3) p. 12343, l. 16ff: replace 'Our data, together. . .' with 'A study carried out in the same peatland 45 years ago provides additional evidence that. . .'

(4) p. 12343, l. 18ff: replace 'We suggest that. . .' with 'We suggest that the higher present day emissions emissions are caused by increased management intensity . . .'

(5) p. 12343, l. 21ff: rephrase 'These two methods. . .'; See comment to line 5. How do your methods confirm the long-term emission potential? The long-term emission

potential is an assumption: you assume emissions started upon initial drainage in the 19th century; which is certainly correct, but cannot be derived from your findings. Possibly delete this sentence.

(6) p. 12344, l. 2-6: suggest to split this sentence: 'In the temperate zone, a peatland with a thickness of 2 m, a BD of 0.1 and a C density of 0.5 holds 1000 tC/ha. When drained C loss is typically 5 t/ha*a (IPCC 2014), implying emissions may continue for 200 years before the peat is depleted.'

(7) p. 12344, l. 21: add comma after 'Thirdly'.

(8) p. 12344, l. 23: also by Driessen & Soepraptohardjo (1974, available here: http://www.eelaart.com/pdffiles/organic_soils_part1.pdf [and ...part2.pdf]) and Ewing & Vepraskas (2006, Wetlands, 26, 119-130).

(9) p. 12345, l. 14: replace 'They are embedded into . . .' with 'They are part of a large peatland complex, the so-called 'Havelländisches Luch', which has formed in the. . .'

(10) p. 12345, l. 19: add source for climate data: DWD station Potsdam (?).

(11) p. 12345, l. 20: write 'ground water table' instead of 'groundwater level'; ditto p. 12346, l. 14; 12351, l. 16; 12353, l. 13; 12354, l. 5; 12358, l. 25;

(12) p. 12345, l. 20: replace 'The recent soil pattern. . .' with 'Present day soils are highly heterogenous with spatial correlation lengths (SOM, soil types) below 30 m.'

(13) p. 12346, l. 3: write 'systematic drainage of the entire 'Luch'. . .'. Amelioration implies improvement, which can be contested in light of your findings. In l. 8 you can write 'conversion' instead of amelioration.

(14) p. 12346, l. 19: replace 'due to' with 'for'.

(15) p. 12346, l. 22: replace 'stands for' with 'represents'.

(16) p. 12346, l. 25: delete 'for that region'.

(17) p. 12347, l. 1: 'replicated' should be 'replicate'.

(18) p. 12347, l. 2: 'close to', write how close.

(19) p. 12347, l. 18: 'estimating' should be 'estimated'.

(20) p. 12348, l. 18ff: looks like the exact method used by Ewing & Vepraskas (2006); Driessen & Soepraptohardjo (1974) present the ash method.

(21) p. 12348, l. 20: Rogier should be Rogiers.

(22) p. 12349, l. 7: delete 'of' at the end of the line.

(23) p. 12349, l. 21ff: 'As reference layers. . .' this is a very cryptic sentence and I propose you rephrase. If I understand correctly, to something like this: 'For reference peat we added together subsequent peat samples starting from the mineral subsoil until ash content deviated by more than 13% compared to the underlying sample.' The question is, why 13%?

(24) p. 12350, l. 11ff: this text belongs to the discussion section, or it may be deleted altogether.

(25) p. 12350, l. 17ff: 'during' should be 'between'; 'The measurements based on the use of' should be 'Measurements were carried out with'.

(26) p. 12350, l. 18: 'bottom size' should be 'area'. Add that chambers were placed on fixed frames that were placed airtight on the soil.

(27) p. 12351, l. 1: 'continuously' should be 'continuous'.

(28) p. 12351, l. 4: 'facultative' should be 'facultatively'

(29) p. 12351, l. 15: rewrite the sentence: In close vicinity to the gas measurement sites, permanent water level tubes were installed.

(30) p. 12352, l. 19: how much of the measured C loss is attributable to CH4, import/export and CO2?

(31) p. 12351, l. 21: delete ‘values of’.

(32) p. 12352, l. 22ff: consider rephrasing, e.g. ‘For both sites profile based estimates of annual carbon loss are considerably lower than chamber based flux measurements. The difference is significant for site P1, but not for site P4.

(33) p. 12353, l. 3ff: rephrase, e.g. ‘The O-alkyl content decreases with depth from >30 % of total SOC neat the surface to values at 20% (P1) or well below 20% (P4) at the bottom of the profiles ([insert type of fit], r = -0.95, p < 0.01). Aromatic content increases with depth from about 18% of total SOC near the surface to >25% at the bottom of the profiles ([insert type of fit], r = 0.83, r < 0.05).’ What regression model did you use to derive the r values?

(34) p. 12353, l. 9: ‘120 years’ should be ‘120-year’; ‘ca. 40 km apart’ should be ‘at ca. 40 km distance’; ‘reveal’ should be ‘reveals’.

(35) p. 12353, l. 12: write ‘variation in groundwater tables coincided with precipitation patterns.’

(36) p. 12353, l. 13: write ‘length’ instead of ‘lengths’.

(37) p. 12353, l. 23: the measured NEE (corrected for harvest) is rather high for sites with the indicated water table. Couwenberg & Hooijer (2013) show a graph of CO2 flux against WT depth and your measurements all fall above the trend line drawn in that graph. Particularly the 2010/11 fluxes are extremely high. How do you explain these high fluxes?

(38) p. 12354, l. 5: write ‘considering that ground water tables were similar’.

(39) p. 12354, l. 6: write ‘Carbon losses derived from the chamber measurements are consistently higher and are more variable than profile based values. In the following. . .’

(40) p. 12354, l. 11f: rephrase ‘and reïňĆects both, variability in space and time’, e.g.; ‘reïňĆecting variability both in space and time’.

(41) p. 12354, l. 12f: rephrase ‘The spatial variability is owing to the locally diïňĂerent position of the three chambers in the ïňĄeld. This spatial variability is similar to that of the soil cores taken for the combined method’, e.g. ‘Spatial variability is related to the micro-site conditions at the position of the 3 replicate chambers and is comparable to the variability in the soil core replicates.’

(42) p. 12354, l. 15ff: rephrase sentence that starts with ‘Carbon dioxide exchange’, e.g. ‘Carbon dioxide exchange of peatlands is highly sensitive to variations in water table, length of the vegetation season and weather conditions in general’. The you write ‘This is in line with variations observed . . .’, but I can only see the variation in flux (and to some extent WT), but not in the other possible drivers. As mentioned before, the measured fluxes seem high and in one year even extremely so. Particularly this extremely high flux deserves additional discussion.

(43) p. 12355, l. 2: write ‘In addition to’ instead of ‘Beside[s!]’; add comma after variation.

(44) p. 12355, l. 3: delete ‘as well’.

(45) p. 12355, l. 4ff: rephrase, e.g. ‘In case of the chamber approach, the effects of chamber deployment remain unclear. Microclimatological conditions in the chamber can cause ecophysiological disturbances that bias the derived C ïňĆux rates (. . .). The frequency and timing of measurement and of model assumptions underlying the calculation of C ïňĆuxes may pose even larger sources of potential bias.

(46) p. 12355, l. 15: ‘both, under’ should be ‘both from’ (no comma). Write ‘and a vertical. . .’

(47) p. 12355, l. 17: rephrase, e.g. ‘peat profiles reflect their development, often including changes in vegetation type, productivity, decomposability as well as layers. . .’

(48) p. 12355, l. 21: write ‘completeness of the C flux captured’

(49) p. 12356, section 4.3: rewrite this section to tighten your line of argument. A)

Polysaccharide content is a measure for decomposability. B) in pristine peatlands the polysaccharide content generally decreases with depth because the lower peat has been exposed to decomposition for a longer period of time. C) However, Fig. 5 shows increasing polysaccharide content with depth, which indicates strong depletion of easily degradable material towards the top of the profiles. D) In former times the peat must have had a higher polysaccharide content also near the surface, enabling high rates of decomposition. E) However, decomposition has increased in recent times compared to the long-term average in spite of the polysaccharide-depleted peat near the surface. F) Whereas one would expect higher rates of decomposition in the past based on the polysaccharide profiles, the opposite is true. Discuss the potential role of a priming effect of root exudates and fresh dead root material in driving C losses in addition to fertilizer application.

(50) p. 12356, l. 22: write 'in the system boundary of'.

(51) p. 12356, l. 23: write 'estimates' instead of 'rates'.

(52) p. 12357, l. 5: avoid 'amelioration', suggest to write 'drainage', as this is what you will in fact look at.

(53) p. 12357, l. 25f: why would higher harvest result in higher C-loss from the soil? Explain and add reference(s). Higher yields may of course be an indication of more intensive farming (stronger drainage) and higher rates of fertilization, but these factors are covered separately. So, would harvest directly affect C-loss or is it yet another proxy for land use intensity?

(54) p. 12358, l. 10ff: what does 'surficial soils' mean? How are they defined? Values are expressed in kg/m2, did Mundel sample the entire soil profile up to the mineral subsoil? This would make sense, but then why call it 'surficial soils'? What does 'adjacent' mean? How far away? Was the subsoil level?

(55) p. 12358, l. 20: 'SOM losses had occurred, linearly increasing with'.

(56) Fig. S2: the figure must show SOM below dams minus SOM in adjacent drained profiles and not the other way around as suggested in the figure heading. How can SOM increase in the drained profiles? Was peat removed when the dams were built? It may be so that the regression is trivial and does not show the result of any process, but rather of random sampling. The SOM stock in a drained profile is likely higher when the adjacent profile under the dam has a (very) small SOM stock and v.v., the SOM stock in a drained profile is likely lower when the adjacent profile under the dam has (very) large SOM stock. In other words: a random distribution of varying SOM stocks over the area would result in a similar graph. If Mundel looked at SOM of the entire profile (which would make sense) the underlying relief may be more important than the actual decomposition of the peat. On the other hand, for intermediate SOM stocks the likelihood of lower or higher stocks in the adjacent profile seems slightly towards lower stock in the drained profiles, which may be expected to relate to peat decomposition. This finding is then summarized in Table 3. Can the figures in this table be trusted in the light of the above?

(57) p. 12358, l. 21ff: refer to table 3 for this finding.

(58) p. 12358, l. 25f: the water table at the flux measurement sites is not particularly low for a drained peatland and in some years even rather high ($\sim$20 cm below surface).

(59) p. 12359, l. 5: 'Paulinenaue', not 'Paulinenause'.

(60) p. 12359, l. 11: profile based approaches integrate over the entire time since drainage, not over ranges of time spans.

(61) p. 12359, l. 13: I agree with the statement, but this conclusion does not follow from the data.

(62) Figure 1: I suggest you write: 'Soil organic carbon at the drained peat sites P1 (solid line) and P4 (dashed line)'; ditto mut. mut. for subsequent figure headings.

(63) Figure 6: '(a)' figures twice. Suggest using colon instead of semi-colon at the end

of the first line.

(64) Suppl. l. 42: ‘ground water table’; it should be noted that Mundel used fixed water tables. Field measurements do not show the decline in emissions at deeper drainage depths, likely because field sites suffer less from desiccated top soils adverse to microbial activity.

(65) Suppl. l. 56: ‘the chamber covered 0.56m2 at their base’.

(66) Suppl. l. 57: ‘with two adjustable fans to assure’.

(67) Suppl. l. 63: delete ‘taken’.

(68) Suppl. l. 64: ‘equipped with a flame’.

(69) Suppl. l. 67: ‘permanent PVC collars’.

(70) Suppl. l. 67: ‘variance’ should be ‘variation’.

(71) Suppl. l. 70: ‘continuous measurements’. Does this mean you had the plots covered by the chambers the entire day? Would this not affect the plants inside, particularly on a bright sunny day?

(72) Suppl. l. 73: delete ‘currently’.

(73) Suppl. l. 74: ‘realized’ should be ‘carried out’. ‘in growing season’ should be ‘during the growing season’.

(74) Suppl. l. 75: ‘and once every 6 weeks’

(75) Suppl. l. 79: delete comma

(76) Suppl. l. 80: add reference for FLUX

(77) Suppl. l. 80f: delete ‘, however,’

(78) Suppl. l. 81f: ‘analyzed by a moving window approach following Hoffmann et al. (2014).’ Delete ‘thereby’; ‘5% of the data’; delete ‘points’; delete all commas; delete

‘ascending’; delete ‘caused by initial chamber deployment’.

(79) Suppl. l. 93: use subscript for the ‘0’ in ‘T0’

(80) Suppl. l. 97: ‘in case the Lloyd and Taylor’

(81) Suppl. l. 107: ‘for the modelling’ (delete process)

(82) Suppl. l. 110: in the equation the G in GPP is in italics

(83) Suppl. l. 115: ‘were set to’

(84) Suppl. l. 124: ‘parameter’ not with capital ‘P’

(85) Suppl. l. 128: ‘kept’ instead of ‘maintained’

(86) Suppl. l. 132: ‘major’

(87) Suppl. l. 136: ‘these’ instead of ‘mentioned’

(88) Suppl. l. 138: ‘sample’

(89) Suppl. l. 146: ‘were randomly sampled 1000 times as well’

(90) Suppl. l. 150: ‘resulting’; delete ‘accordingly’

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