

## Reply on RC3

Brieuc Hardy et al.

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Author comment on "Identification of thermal signature and quantification of charcoal in soil using differential scanning calorimetry and benzene polycarboxylic acid (BPCA) markers" by Brieuc Hardy et al., SOIL Discuss.,  
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The manuscript from Hardy et al. investigates the potential for differential scanning calorimetry to characterise charcoal and quantify BC in soils. The paper uses soils from croplands and forest soils with pre-industrial charcoal kilns to characterise the thermal signatures and quantify of charcoal C content. The manuscript also compared the accuracy of BC quantification from DSC to the benzene polycarboxylic acid (BPCA) method using a subset of samples. The paper provides an insight in to the continuum of charcoal and BC using DSC as a methodology of determining charcoal C content.

Overall the paper is well written and the authors address the aims of the manuscript clearly. The introduction and methods are concise and well presented. I have some minor comments about the methods and results in the specific comments below. The discussion follows the results well and places the study in the current literature. I believe this is a well conducted and presented manuscript with data that are unique, and findings that fit within the scope of the journal.

*Authors: First we would like to thank Referee 3 for his time and helpful comments that will help improve substantially the quality of the manuscript. A point-by-point answer to specific comments raised is provided below.*

### Specific comments

Line 14: Consider rewording sentence, potentially, 'sustainably improve soil fertility'

*Authors: Accepted as proposed by Ref 3 : "Black carbon (BC) plays an important role in terrestrial carbon storage and can sustainably improve soil fertility."*

Line 33-34: Consider rewording to '...interpretable information across the continuum of ...'

Authors: Accepted in the formulation proposed by Ref 3

Line 101: For the soils collected in Belgium, what was the depth of topsoil sample?

Authors: for cropland soil the depth of sampling was 0-25 cm; in forest, soils were sampled by soil horizons (Hardy et al., 2016) so the depth of sampling was not constant. Organo-mineral (A) (sub-)horizons are considered here. The depth of the A horizon was generally about 0-10 cm for reference soils but generally much deeper (up to 50 cm deep) for CKS soils.

We propose to complete the sentence: "Two series of organo-mineral topsoil samples of kiln and adjacent reference soils from forest (**sampled by (sub-)horizons**, N=38; described by Hardy et al., 2016) and cropland (**0-25 cm depth**; N=34; described by Hardy et al., 2017a) were analyzed."

Line 167: Can you explain the selection of charcoal concentrations in more detail?

Authors: Proposed reformulation : "..., we mathematically simulated soil-charcoal mixtures (n = 18) over **a representative range** of charcoal-C concentrations (**from 5 to 90 % of TOC**) based on the DSC pattern ..."

Line 173 change 'previously' to 'prior'

Authors: Accepted and already suggested by Ref1

Figure 4: Caption refers to soils from Wallonia and German, which is confusing because in the methods they are labelled as either German or Belgium soils. Suggest changing Wallonia to Belgium in the caption.

Authors: Accepted. The text will be harmonized accordingly, "Belgium" will be preferred to "Wallonia".

Figure 6: figure has the R2 value but no line fitted or coefficients listed?

Authors: The coefficient is a correlation coefficient ( $r=0.935$ ), the corresponding determination coefficient would be ( $R^2=0.874$ ). As a correlation coefficient refers to a linear relationship by nature an extra line would be somehow redundant. The correlation coefficient was preferred here to the use of a  $R^2$  because there is no intention of calibrating a regression line here, in contrast to e.g. Figure 7.

Figure 7: Too many significant figures

Authors: We guess too many significant digits? Will be harmonized between all figures and limited to two or three in the revised version depending on the recommendations of the

Journal

Figure 7: caption doesn't explain 7a or 7b explicitly

*Authors: Thank you for this. Here is a proposition of revision of Figure caption : "Figure 7. Charcoal-C content estimated by DSC against BPCA-C content in the soils from Germany, expressed as a fraction of TOC content (a) or in absolute terms (b)"*

Line 208: august to "August"

*Authors: will be revised accordingly*

Line 212: any statistical tests to measure these differences

*Authors: Unfortunately, as we refer to only one single "fresh" charcoal produced by the mound kiln method, the application of a statistical test is impossible*

Line 222: keep the naming of R2 consistent

*Authors: We suggest to keep the use of correlation coefficient when the aim is to study the linear character of a relationship between two variables, whereas the use of the determination coefficient is useful when a regression line is necessary (e.g. on Figure 7 a) and b) where the slope of the relationship is critical for method comparison)*

Line 226: change 'more than twice smaller than' to 'less than half of'

*Authors: Accepted in the proposed formulation*

Line 230: "c. five"?

*Authors: we propose to reformulate the sentence, according to comments of Ref1 and 3:*

- *Former sentence: "the content charcoal-C estimated by BPCA-C differs by a factor of c. five as compared to the amount estimated by DSC"*
- *changed to "total BPCA-C content underestimated the amount of charcoal-C predicted by DSC by a factor of around 5"*

Line 235: consider changing 'mineral background' to 'mineralogy'

*Authors: Accepted*

Line 242: consider changing "to get rid of" to reduce, remove, minimise.

*Authors: "remove" will be preferred (cf Ref 1 who also suggested a change)*

Lines 267-268 ("A positive ..."): Sentence is confusing, consider rewording

*Authors: proposition of rephrasing => "Consistently, the content of aromatic-C estimated by <sup>13</sup>C NMR spectroscopy correlates positively with the proportion of thermally refractory SOM (Harvey et al., 2012; Leifeld, 2007)."*

Line 275: Consider rewording sentence.

*Authors: proposition of rephrasing => "The temperature of the thermally most stable peak was proposed as the most reliable feature to assess the thermal stability of charcoal."*

Line 284: "which may explain the lower ..."

*Authors: "smaller" will be changed to "lower"*

Paragraph 1 of section 4.2 does not discuss any results. Whilst it is relevant information how it relates to the current study is not clear.

*Authors: Indeed this short paragraph doesn't refer to results of the manuscript but we believe that it brings critical information for the understanding of the thermal signature of charcoal compared to uncharred SOM. Therefore we propose to keep the paragraph in the text.*

RC3: Some figures and captions use comma or a decimal point (i.e 96,3 vs 96.3). Figure 4 and 6 uses a decimal point, whereas 5 and 7 use commas

*Authors: Thank you for this. Indeed we need to harmonize, and we propose to replace all commas by dots for decimals where needed (on the two mentioned figures and in the text where needed)*