

## ***Interactive comment on “Comparison of different methods to determine the degree of peat decomposition in peat bogs” by H. Biester et al.***

**Anonymous Referee #1**

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This paper aims to evaluate peat decomposition proxies as indicators for decomposition processes in two ombrotrophic mires. They characterize and compare several measures of decomposition proxies in depth profiles of these mires, including pyrolysis-GC-MS, C/N ratios, stable isotopes of C and N, FTIR spectroscopy, Rock Eval oxygen and hydrogen indices, and humic acid UV adsorption.

This study is an impressive and comprehensive comparison of different methods used to quantify OM decomposition. The authors highlight that depth profiles of many of these indices are both affected by decomposition processes, vegetation changes, and possibly other external and internal factors (e.g., N deposition and recycling). A particular strength of this study is the use of molecular analysis using GC-MS attempt to differentiate between these processes and discuss the performance of each the

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decomposition proxies in regards to molecular tracers. As mentioned, this is a very comprehensive characterization of biogeochemical decomposition measures in peat bogs with high relevance for climate reconstruction and characterization of historic deposition inputs of trace elements. The analyses, although I am not fully familiar with all of the techniques used, seem very sound, are well described, and seem to have appropriate quality control measures. Overall, this is a highly suitable paper for publication in Biogeosciences. The introduction is very well written, clearly lays out the issues with many of these decomposition proxies, and is very well referenced – in short, it does an excellent job to highlight the need and importance of this study.

My major concern with the paper is the current structure of the results and discussion sections which makes it very difficult for the reader to understand the analysis, comparisons, and their respective interpretations. One reason for this may be that the paper is extremely dense and comprehensive, and as such presents a vast amount of data and chemical analysis which are difficult to fully absorb. However, I had to read the results and discussion sections many times in order to understand the direction and interpretation of all analysis performed. I strongly suggest that these two sections need to be comprehensively restructured for the readers to be able to follow the arguments made by the authors – see section below for some suggestions.

In particular section 4.3. and the following subsections (4.3.1 through 4.3.5) are extremely cumbersome to follow. I think the main reason is the introduction of the Principal Component Analysis (PCA) and the two factors F1 and F2 that represent water table heights and degradation of vascular plants based on analysis of GC-MS data. While this is very elegant analysis to compare decomposition measures to molecular tracers, the authors need to prepare the reader much earlier and more directly for this approach. For example, they should make it a specific goal in the introduction that their evaluation of decomposition proxies is based in large parts on molecular analysis and PCA factors, and clearly state that the factors allow to differentiate between processes contributing to changes in decomposition proxies (i.e., water table height af-

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fecting species abundance and decomposition, and decomposition of vascular plants). If this is clearly laid out in the introduction, and the results and discussion section also put an emphasis on this approach, it will be much easier to follow comparison of other decomposition proxies to this approach. Similarly, figures should be re-arranged in a way to help this restructuring. For example, Figure 4 introducing the two main factors should be very early in the manuscript and be discussed early in results and discussion sections. Currently, figure 3 and many text sections show and discuss PCA factors F1 and F2 before they are clearly discussed and interpreted. Then, I suggest that a more structured comparison of decomposition proxies to these factors should be done; for example, in Figure 5 only one regression is shown relating decomposition proxies to F1 (i.e., for C/N), but large parts of sections 4.3.1 through 4.3.5. specifically discuss relationships to F1 and F2 to decomposition proxies without showing these relationships. To help this, the correlation matrix between factors F1/F2 and decomposition proxies currently shown in Suppl. Table S3 could be moved to the main text. Other figures of the manuscript (e.g., Fig. 1, Fig. 2, and possibly Figure 3) could possibly be moved from the main manuscript to the supplemental information.

While I do not insist on restructuring the manuscript exactly the way I mentioned above, I need to re-emphasize the need to restructure the results and discussion section. This is really a great dataset with unique and elegant analysis and interpretations, but I think in its current form many readers will be overwhelmed and not be able to follow the reasoning of the authors without repeated reading.

Other comments: Page 17352: Abstract: what is missing in the abstract is the entire approach using PCA analysis and PCA factors based on molecular characterization and their relationships to decomposition proxies. This is one of the main aspects in discussion and should be clearly mentioned and described in the abstract.

Page 17352, line 8: "if not misleading" – clarify what is meant here or reword, why/what is misleading?

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Page 17352, line 17: define abbreviation "UV-ABS" when first mentioned

Page 17352, line 25: "showed less variation" – less than what, do they mean they were stable through the profile?

Page 17352, line 28: "reasonable information despite their bulk nature" clarify what is meant and reword

Page 17353, line 21: "has been reported recently" delete recently as these studies are over 10 years ago now.

Page 17354, line 16: add reference

Page 17354, line 17: write out versus

Page 17355, line 11: add reference about the impact of fire incidence.

Page 17355, line 19: "more narrow" I assume they mean lower C/N ratios indicative of more decomposed peat material?

Page 17357, line 4: reword the entire sentence starting with "Unless the fact that. . ."

Page 17357, line 20, the authors use H/C and O/C indices earlier in the manuscript and here use HI and OI (I guess they mean hydrogen and oxygen indices) – they should be consistent with the terminology through the manuscript and in figures.

Page 17359, line 22: define GC-TCD

Page 17362: Results: a very important component of the discussion is based on PCA and comparison of decomposition proxies to factors F1 and F2. This should be presented in the results section, which will make the discussion easier to follow.

Page 17362, line 12-18; and Table 1 and 2: the authors should show stdev in Table 1, and discuss if  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  are statistically different instead of stating "slightly lighter"

Page 17362, line 23: "a similar trend of increasing values. . .": the authors should quan-

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tify the similarities of trends, e.g., by referring to the correlation matrix or perform consistent scatterplots/regressions between different proxies.

Page 17363, line 2: “seem to show inverse relationship...” same as above, please quantify.

Page 17363, line 24: “a remarkable sharp decrease...” this was also observed in the KK profile at about 43 cm depth, why not mention and discuss that also for the KK profile?

Page 17363, line 12: “do not correspond to those of any other decomposition proxy” – as mentioned above, the correlations/correlation matrix should be done for all proxy comparison to quantify similarities/differences between proxies.

Page 17363, line 3: for that reason, molecular component were only determined in the KK core” I have not problem that molecular composition was only determined in one core, but I would remove the justification given – as mentioned above, some of the traditional decomposition proxies show differences between the cores.

Page 17365 and 17366: section 3.2.1. and 3.2.2. The reason for presenting these vegetation markers and molecular characterization becomes only clear later in the discussion section and the use of these markers in Figure 4. It would help tremendously if the reader is prepared for the use of these markers in the PCA analysis and their factors, maybe make a separate results section how the markers are used to develop factors F1 and F2 which will then be compared systematically to traditional decomposition proxies.

Page 17366 and following: The discussion should start with a detailed description of the use of PCA and Factors 1 and 2, and their interpretation, and then systematically interpret all traditional decomposition proxies in regards to this analysis. This would greatly help to follow the manuscript.

Page 17366 section 4.1; This section would be much clearer to follow if analysis of

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molecular tracers was done first ad the authors already discuss relationships to factors F1 and F2 although it is not clear yet what these mean.

Page 17373, lines 4: “the fact that in our KK peat not lignin...” reword

Page 17374, line 12: A comparison of the FTIR intensity... is given in Suppl Fig S4). This should probably be mentioned earlier in this discussion section, why introduce new results at the end of a discussion section? Section 4.3.3. Be consistent with the use of O/C and H/C and OI and HI.

Page 17378, line 7 reflecting change in mass loss and ARE related...

Page 17378, line 10 : change “sand” to and

Page 17378, line 18: change “despites” to despite

Page 17379, line 13: change “correlates” with correlate

Page 17379, line 22, remove comma before changes

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