Author Comments on “Technical Note: Rapid image-based field methods improve the quantification of termite mound structures and greenhouse-gas fluxes”, by Philipp A. Nauer et al. (bg-2018-43)

Response to Anonymous Referee #3

(1) comments from Referee

Nauer and coworkers present the efficiency of Photogrammetry (PG) method using Structure from Motion (SfM) by comparing with CT scan method. Complexity of termite mounds in ecosystems have made us difficult to understand the internal structure (both macro and micro pores), thus, biogeochemical reactions inside the termite mounds. This study provides simpler and more reliable ways to understand the internal/external structures of termite mounds than conventional simple geometric shape methods. The results of this study can be utilized for more accurate estimation of termite population and GHG emission in various ecosystems. If the estimation of spatial distribution of termite mounds in each ecosystems will be combined, we can estimate ecosystem scale GHG emission more accurately. Therefore I can recommend the manuscript for publication as a technical note in Biogeosciences only after technical corrections. I suggest several points as outlined below.

- *P3,L1 CH4 oxidation “by termite mounds”*
- *P12,L15-P13,L3 This part should be moved to “Introduction”.*

(2) author's response and (3) author's changes in manuscript.

We sincerely thank the reviewer for her/his consideration and time invested in improving our manuscript. Please find our replies to the reviewers’ specific suggestions below, with page and line numbers referring to the discussion manuscript.

Comment “P3,L1 CH4 oxidation “by termite mounds”
We incorporated the suggested change as CH4 oxidation “in TMs”, to be consistent with our terminology.

Comment “P12,L15-P13,L3 This part should be moved to “Introduction”
We agree with the reviewer, and the suggested changes have been implemented. The sentences have been moved to P2,L31 onwards, including some minor modifications as follows, to improve text flow:
“Photogrammetry (PG) via digital surface reconstruction is a relatively new low-cost approach to document and measure complex three-dimensional structures in nature. For example, PG has been embraced by the archaeological community for the documentation of cultural heritage sites (De Reu et al., 2013), used to measure the bulk density of soil clods (Stewart et al., 2012), measure shapes and dimensions of aquatic organisms (Lavy et al., 2015) and determine the diameter and biomass of buttressed and irregularly shaped tropical tree trunks (Bauwens et al., 2017). However, this approach has not been applied on TMs; therefore, there is currently no accurate, reliable, non-invasive method to determine the critical external physical parameters of TMs such as VE, AE and AB.”

Author Comments on “Technical Note: Rapid image-based field methods improve the quantification of termite mound structures and greenhouse-gas fluxes”, by Philipp A. Nauer et al. (bg-2018-43)

Author Response to Anonymous Referee #4

(1) comments from Referee

General comments: I think that this technical note is well written, and the theme is also acceptable in this journal. I listed some questions and comments for this manuscript (see below), which I hope the authors will consider and respond to in revising the paper.

Specific comments:
In PG method, the authors used photo images to estimate structure of TM successfully. I feel that if photo image can provide us other biotic/abiotic information of TM such as termite species, material, age and wetness of TM via color analysis, advantage of the presented method will be increased. One of the presented method, cross-section is destructive method. Does PG have potential to estimate TM internal structure? For example, if endoscope images can be used for PG (SfM), we may measure internal structure with (relatively) small damage of TM. In addition, the authors analyzed the painted cross-section color images by using 2D image analysis software. This method is very simple and I can agree it. However, if micro- and micro-pores can be also calculated by SfM technique using multiple cross-section images, it may also become interesting application.

P1 L13 Please clarify (mention the name of) two novel field methods and established method in the first part. Because results of four methods (PG, CT, water displacement method and conventional approach using simple geometric shapes) were introduced in this abstract, the readers may be confused.
P2 L8 (Figure 1) This figure is good for readers to understand morphological parameters of TM.
P2 L9 termite mound (TM)
P3, L20 Please add the explanation of backgrounds (outline, expected merit) of (1) PG and (2)image analysis method.
P6 L21 If water content of TM affects the image analyses in the cross-sectioning method and CT scan method, please mention the predicted points to be noted for accurate measurement. The photo image of CT scanning would be good for understanding the measurement protocol.
Table S1 Explanation of abbreviations (Mn, Ms, Tp, rB, V etc.) in table would be help for readers to understand the datasheet easily.
P8 L16 Are these relationships significant in each termite species?
P15 L16-20 Application in various scales is very important. If we can use this method commonly in long-term monitoring of TM by using UAV images, ecological knowledge about spatial/temporal distribution and growth rate of TM will be discussed

(2) author's response and (3) author's changes in manuscript.

We sincerely thank the reviewer for her/his consideration and time invested in improving our manuscript, and the interesting ideas on further improvements of the methods. Please find our replies to the reviewers’ specific suggestions below, with page and line numbers referring to the discussion manuscript.

Comment “In PG method, the authors used…”
The reviewer proposes interesting potential improvements for the presented methods, which merit further investigations. In particular, the combination of endoscopy with SfM reconstruction appears ingenious for partial or full internal structural analysis of a TM. Some of the proposed ideas have been discussed in the manuscript, e.g. (P15,L26) the measurement of internal porosities entirely

with PG using the "clodometer" approach (Stewart et al., 2012), and we can highly encourage future research in this direction. However, even though we recognise the great potential of the proposed ideas, we regret that it was beyond the scope of our study to investigate further applications of image analysis and photogrammetry on TMs.

Comment "P1 L13 Please clarify…"
Thank you for pointing out this potential source of confusion. We slightly modified the abstract to introduce and name the two novel methods earlier in the text (P1,L13-14), and explicitly name the established methods for comparison (P1,L16 and P1,L19).

Comment "P2 L8 (Figure 1)…"
We are grateful to the reviewer for the appreciation of our figure. No changes have been implemented.

Comment "P2 L9 termite mound (TM)"
The words "termite mound" have been replaced by its abbreviation "TM" on P2,L9, also on P3,L20.

Comment "P3, L20 Please add the explanation…"
We thank the reviewer for this valid suggestion, but feel that further background and expected merit of the two methods would unnecessarily overload this paragraph, which was intended to state our aims and objectives as clearly as possible. We hope this is ultimately in the readers' interest. However, we included a brief statement on the methodological basis of the PG method (P3,L21): "i) a PG method based on structure-from-motion (SfM) reconstruction from digital photographs, to determine epigeal…"; and amended the statement on image analysis as follows (P3L22): "ii) an image-analysis method based on painted cross-sections to determine…".

Comment "P6 L21 If water content …"
We recognize that this important point has not been sufficiently clarified in our manuscript.
By painting the surface of the cross-sectioned TMs with a bright, distinct colour, we ensured that the image analysis was not biased by any properties of the wall material, including water content. A respective sentence has been added to the manuscript (P6,L26): "…wall surface, thereby creating a distinct, uniform surface independent of the properties of the mound material (Fig. S3a)."
Similarly, water content did not influence the CT scans of TMs as it is present only in micro-pores and therefore invisible due to the limited resolution of the medical-grade CT scanner. A respective phrase was included in the supporting information (P3,L13).

Comment "Table S1 Explanation of abbreviations"
We thank the reviewer for pointing out this oversight. Respective explanations have been added to the table caption.

Comment "P8 L16 Are these relationships significant in each termite species?"
An interesting point, and even though this question was not within our main focus, we recognise that readers might be interested in the significance of this relationship. We thus tested the correlation between epigeal volume, area and basal area for significance between species with linear regression; the overall correlation was significant for both areal parameters, but differences between species were not significant.
Respective phrases were added in Materials and Methods and Results sections:
(P7,L27) "…calculated from t-statistics. Significant differences (α = 0.05) between termite species' structural parameters were tested with One-Way ANOVA, and correlations between epigeal measures with ordinary least-square regression."

(P8,L17) “Correlations with V_E were significant for both parameters, with insignificant differences between species.”

Comment “P15 L16-20 Application in various scales…”
We thank the reviewer for highlighting this important aspect. We tried to incorporate it into the manuscript with an additional statement in this discussion paragraph: (P15,L18) “…LiDAR systems (Davies et al., 2014; Verhoeven, 2011). Long-term aerial monitoring of TMs may thus inform not only on a spatial but also a temporal scale, e.g. on TM growth and decay rates, as well as temporal shifts in abundance. Furthermore, combining such information with biogeochemical rates has the potential to…”