We would like to thank referee #1 for his thorough review and fair assessment of the first submission. We will incorporate almost all suggested changes in the revised draft. In a few cases we explain in detail why we decided against it. Referee comments are reproduced in italic font and answers are highlighted in bold font.

General Comments

The authors present a study on the identification of soil properties which explain the differences in carbon mineralisation following a land use conversion. For this they apply classical experimental methods, the very promising X-ray CT method and statistical analyses. I see sound scientific work all over. Further, the manuscript is well-structured and written in a concise style. I made some suggestions with respect to the written English, however I am also not a native speaker. Nevertheless, I identified two issues. I guess both could easily be resolved. I am not convinced that the PCA provides any new or fundamental findings that could not be determined via the extensive regression analysis presented in this study. Thus, i suggest to remove the PCA. The second issue is related to the conclusions section. It contains hardly any conclusion and is rather a summary. This should be entirely rewritten (see spec. comments). Given this, I suggest major revisions.

Answer: The complete removal of the partial least square regression (PLSR) results from the MS would not give due credit to the high level of collinearity in the data set, a major problem of extensive regression analysis. Therefore, we decided to outsource only the graphical representation of PCA (biplots in Fig 6 & 7) into the supporting information, but not the graphical representation of explained variability by different models (point graphs in Fig 6 & 7). We have completely rewritten the conclusions as suggested (see below).

title: What about 'Land use impact on carbon mineralization is rather caused by variations of particulate organic matter than of soil structure'? Just a little shorter...

Answer: Agreed.

17 replace 'farming' with 'agriculture'

Answer: We prefer to abide by the terminology given by the original Global Change Exploratory Facility publication

27 'to' is missing after 'due'

Answer: Changed.

29 please add 'the topsoils of' before 'croplands'

Answer: Added.

35 well, the fact that microbial biomass is correlated with substrate-induced respiration is not much of a surprise ...

Answer: We agree that this is not surprising. The first part of the sentence is mainly meant to give an R². The second part of the sentence is more important, i.e. it's mainly correlated with particulate organic matter content, but not at all with pore metrics.

60 replace 'moisture' with 'water'

Answer: Changed.

62 I guess you should be more precise about the 'initial flush' as a consequence of soil disturbance. Is this initial flush hours, days or weeks? And in contrast Herbst et al. 2016 actually detected signifiant differences in basal C mineralization between disturbed and undisturbed samples incubated at the same water content for five days following a conditioning period of seven days after disturbance.

Answer: Thank you for pointing this out. The pre-incubation period had been two months. That is much longer than the actual incubation period chosen by Herbst et al. This information will be added to the text.

85 better write '.. to assess how these microstructural'

Answer: Changed.

99 better write 'Each land use treatment is replicated five times...' cause you do not make use of the climate treatments in this study. As written now this would rather confuse the reader.

Answer: Agreed.

178 eq. 1 In the end this is a matter of taste, but I would suggest to write the formula as 'p_si(t)=A+B*exp(ut)' and replace the 'e' with 'exp' cause otherwise the reader might search for the variable 'Be'

Answer: We've added a space between B and e instead.

194 The statistical analysis procedure is sound. I would just point to the fact that the error probability level of 0.05 is an absolutely arbitrary choice. You are doing a lot of sophisticated statistical analysis based on an arbitrary choice. I know it has been done for ages like this, which could also serve you as a justification ... Just be aware.

Answer: Thank you for pointing this out. This is just a matter of condensing information in a table or figure really. In the main test we prefer to give the actual p-value instead.

203 I would refer the reader to table 1 at this point, otherwise all the symbols might be a little overwhelming

Answer: Agreed.

217 well, 'manually selected' actually means something like 'variables selected based on expert knowledge', which may be a more precise statement

Answer: Changed.

227 'no difference in average bulk density' don't you think this is related to the time since conversion? I would assume that it will actually take a long time. May be you find some literature data for the same type of land use conversion.

Answer: You are right. We tried to avoid the term "long-term land use trial" in the entire paper as we are aware that <10 years since conversion might be too short to fully develop a dynamic equilibrium in carbon content, pore structure, etc. We now start the discussion with the following statement:

"A duration of six years is quite short in comparison to common long-term land use trials. Nevertheless, land use specific soil management already started to affect soil structural properties, which showed particular large differences between grasslands and croplands."

235 table 1 Units! There are some flaws in the units, please check. POM is probably mg g^-1 (not g^-3), there is a '1' too much for the basal respiration unit and the '-1' for TMP and AMB should be upper case.

Answer: Thanks a lot for the sharp observation. Changed.

254 remove one '.' at the end of the sentence

Answer: Removed.

262 Well, I would not refer to a R2 of 0.53 as a 'strong' correlation. Just a little more than half of the variation is explained ... I suggest to moderate this statement. And strictly spoken: A coefficient of determination is not a correlation coefficient.

Answer: We will replace 'strongly' by 'well' and give p-values as a second metric to give complementary information and the agreement between the two metrics. 'Correlate' will be replace by 'variation explained'

264 'independent of initial water saturation' well, there is actually not too much variation in the initial effective saturation. And the differences that may be resulting from differences in water stauration are probably counteracted by POM content: lower saturation but higher POM...

Answer: We would argue that the variation is quite high (0.2-0.7), given that the full theoretical range is never reached due to the permanent wilting point at the dry end and air entrapment and quick drainage at the wet end. We agree that saturation effects are counteracted by POM effects. In fact, this is one of the main findings of the paper. However, we prefer to give this level of interpretation in the discussion section.

271 Generally, I do not think that SIR is reperesentative of what is happening under real-world conditions. The C source is totally liquid-phase and soil is almost entirely water saturated, which rarely occurs under field conditions.

Answer: We agree that the SIR is an assessment of respiration potential under somewhat standardized, artificial conditions. Nevertheless, we decided to report both basal respiration and glucose-induced respiration results to have two very different mineralization scenarios in order to find out under which conditions the pore structure matters at all. Please note that the water saturation after glucose solution addition might be lower than you think, because all samples had been drained on a sand bed as the final step of sample preparation resulting in air contents of 9-12%. That's almost a quarter of the entire pore space.

276-278 so, this is all a measurement error?

Answer: No, certainly not. Plant residues exert a dominant effect on basal respiration, but just matter less when the soil is provided with glucose. This is not an error but a feature. The difficulties in determining p_0 for some soil cores by manual outlier removal during the initial lag phase could indeed be ascribed to measurement errors. In principal, we could have used the p_0-p_B relationship to guide this lag time estimation, but we chose to do this independently. We prefer to give both types of information and let the reader decided whether the removal of these points is warranted.

286-287 I think that p_0 and the t_{exc} are very redundant. A higher SIR will inevitably lead to an earlier excess of respirometer uptake capacity. Basically, the R2 should be 1...

Yes, in this study with intact soil cores they are redundant, but this is not necessarily the case. Many SIR studies with sieved soil show quite the opposite due to very different grow rates (μ). That is, a sample can start at lower p_0 but reach t_{exc} sooner, due to faster growth. The fact, that μ is very similar for all cores suggests that the intact structure may induce substrate diffusion limitations, i.e. μ is not really μ_{max} for unconstrained growth. This would be an interesting finding that, however, needs to be underpinned by independent measurements.

296 For the C:N ratio this might be explained by the fact that the C:N ratio of the biomass of crops and grassland is rather similar?!

Answer: Yes, that could be the case. However, at this point in the result section we prefer not to add more interpretations, as the paragraph is meant to be a quick wrap-up.

312 I guess this should be Fig. 6a and not Fig. 7a

Answer: Changed.

320 I guess this should be Fig. 6b and not Fig. 7b

Answer: Changed.

325 i do not think that the PCA contributes anything new or viable. I suggest to remove the PCA.

Answer: We will outsource both PCA biplots to the supporting information.

337 I guess this should be Fig. 7a and not Fig. 8a

Answer: Changed.

347 I guess this should be Fig. 7b and not Fig. 8b

Answer: Changed.

395 I do not think that those statements can really be validated with an R2 of 0.39. I strongly suggest to moderate the statements.

In light of huge uncertainties in image-derived POM volumes and the very low p-values (p<0.001) of this regression we would argue that an R²=0.39 is not that bad. Nevertheless we will moderate the statement to "In general, drier soil cores were associated with higher POM volume…"

405 replace 'overlooked' with 'additional'

Answer: Changed.

436-450 The conclusions section is rather a summary than any real conclusion. Basically, only lines 447-450 contain some conclusions and even those are rather common statements. I suggest to entirely rewrite the conclusions sections, simply refer to the objetives stated at the end of the introduction.

We had the impression that our previous Conclusions section already addressed all three objectives rather well. Nevertheless, we tried to rewrite it to accommodate your comments. We would be grateful for a quick feedback, whether we have met your expectations. The revised conclusions are as follows:

"While the observed influence of land use on carbon mineralization in terms of basal respiration and glucose-induced respiration were expected, the reason behind the observed pattern was not. Neither field water content, which is one of the main drivers of basal respiration known for disturbed, i.e. sieved, soil nor land-use specific microstructural soil properties improved the prediction of carbon mineralization. If strong correlations between microstructural variables and carbon mineralization were observed, then they did not arise from causation but collinearity, and could easily by replaced with cheap bulk properties without substantial loss in predictive power. The POM content was the bulk property that described basal respiration best across all land uses under well-aerated conditions. This suggests that in intact soil cores, the decomposition of particulate organic matter contributed a large share of CO_2 emissions, which masked the commonly described variation of C mineralization related to soil water saturation. The POM content also exerted a strong impact on the speed of glucose mineralization, as it governed the initial microbial biomass, whereas the growth on glucose was equally constrained in all soil cores by diffusion limitations imposed by the intact pore structure.

Additional incubation experiments after repeated sampling of the plots at different stages of the growing season and different precipitation history, including the different climate scenarios of the

GCEF, will provide a more comprehensive data set in the future. By this, the governing state variables responsible for carbon mineralization vary a lot more due to seasonally changing soil POM contents brought about by roots and fresh litter, different soil moisture as well as varying shoot-to-root C allocation ratios of plants. Since understanding C mineralization under various conditions is crucial for proper C modeling, different soil types but also inter-annual differences, accounting for the effects of different plants within the crop rotation and plant composition dynamics in grasslands should be considered in future studies as well."