

Interactive comment on “Soil properties override climate controls on global soil organic carbon stocks” by Zhongkui Luo and Raphael Viscarra-Rossel

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This is a well-written and very worth-while study that will be of high interest to readers. There are a few grammatical issues that should be carefully checked before publication. I have some questions about the analyses that need clarification below.

Response: Thank you for these positive comments. We will carefully re-check for any grammatical issues. For the questions raised, below, we respond point-by-point.

(*Note, I was unable to open the supplemental materials file and it's possible that some of the information I'm asking for is there)

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Biotic covariates- Is there any attempt to account for how different plant functional types contribute different amounts of their NPP to soil carbon, or is all NPP assumed to have the same contribution to soil C? Can this be accounted for by land cover type somehow? A lot of NPP does not contribute much to SOC. For example, in DayCent the metabolic:structural ratio is used to estimate this, which is based on the lignin:N ratio of litter. The LiDEL model (Campbell et al., SBB) also provides another example of how litter chemistry can dictate the amount of soil C input from different types of plants.

Response: These are good questions. We included land cover type as a predictor reflecting plant functional types. The land cover type data is from MODIS land cover product. The result is that land cover type is less important than total NPP. The reviewer is right that the contribution of NPP to soil carbon might be strongly dependent on plant functional types. The quality of NPP may be also important such as the nutrient content. Unfortunately, we do not have detailed data to test this. We will expand the discussion on the potential importance of plant traits.

GBM model- It appears that the same edaphic factors were used to gap-fill missing BD values and SOC stocks (in the BRT model) as were used in the GBM model to determine the weight of influences of different factors on SOC. Since the vast majority of the data was missing BD, doesn't this mean that the edaphic factors are overweighted/double counted in your analysis?

Response: Thanks for raising this concern. We understand the reviewer's concern that the edaphic properties that had been used to infer BD had been double counted. Here, it should be noted that we only included several limited soil properties for SOC stocks (Table S1 in the manuscript), while 45 soil properties have been used due to the purpose of the GMB modelling is to fill missing BD. We will exclude those soil properties that will be used for SOC stocks to re-fit GBM models to predict BD. Considering that our analysis is at the global scale, this conduction would have little effect on the predictive power of the GBM model. This exercise will eliminate the double counting

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issue.

PCA- the PCA of the climatic variables is a nice approach. Why didn't you do the same for the edaphic properties, since many of them are also co-variates?

Response: We saw that at least some of the climatic variables were highly correlated, while the the edaphic factors were less correlated. However, we agree that at least some of the edaphic properties will be correlated and so we will re-analyse the data to check and potentially also perform a PCA of these properties. Thank you for the comment.

Discussion- Is soil LL15 an edaphic property? Isn't it also related to climate and vegetation?

Response: Thanks for this question. In this study, LL15 is defined as lower limit under the pressure of 15 bar. It is inherently an edaphic property determined by soil texture and structure.

Does NPP have any greater influence on deep SOC in wetter environments than dry, indicating the importance of leaching in translocating plant inputs deeper into the soil? This would be very interesting to know.

Response: This is an interesting question. However, this study cannot explicitly quantify the importance of leaching in translocating carbon inputs. Also, please note that, in dry environments, roots may go deeper to find moisture. So, carbon transport due to leaching may be less in dry areas, but stimulated root growth would enhance root-derived carbon inputs in deeper layers. The effect of NPP may be complex, depending on plant functional types (Reviewer #1 mentioned this point), soil hydraulic properties, climate seasonality, etc. We will discuss the potential divergent effects of NPP on SOC stocks taking into account its interactions with plant functional type, soil and climate.

Uncertainties and Limitations- Did you included agricultural and managed landscapes into one analysis? It seems like you should split converted/managed lands into a sepa-

rate analysis from non-managed lands due to this large impact of disturbance that you discuss here.

Response: Thanks for pointing out the importance of land management. Yes, we did not distinguish between natural and managed lands. We acknowledge that more detailed assessment is worth additional study. In the revision, we will highlight the importance of disturbance.

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